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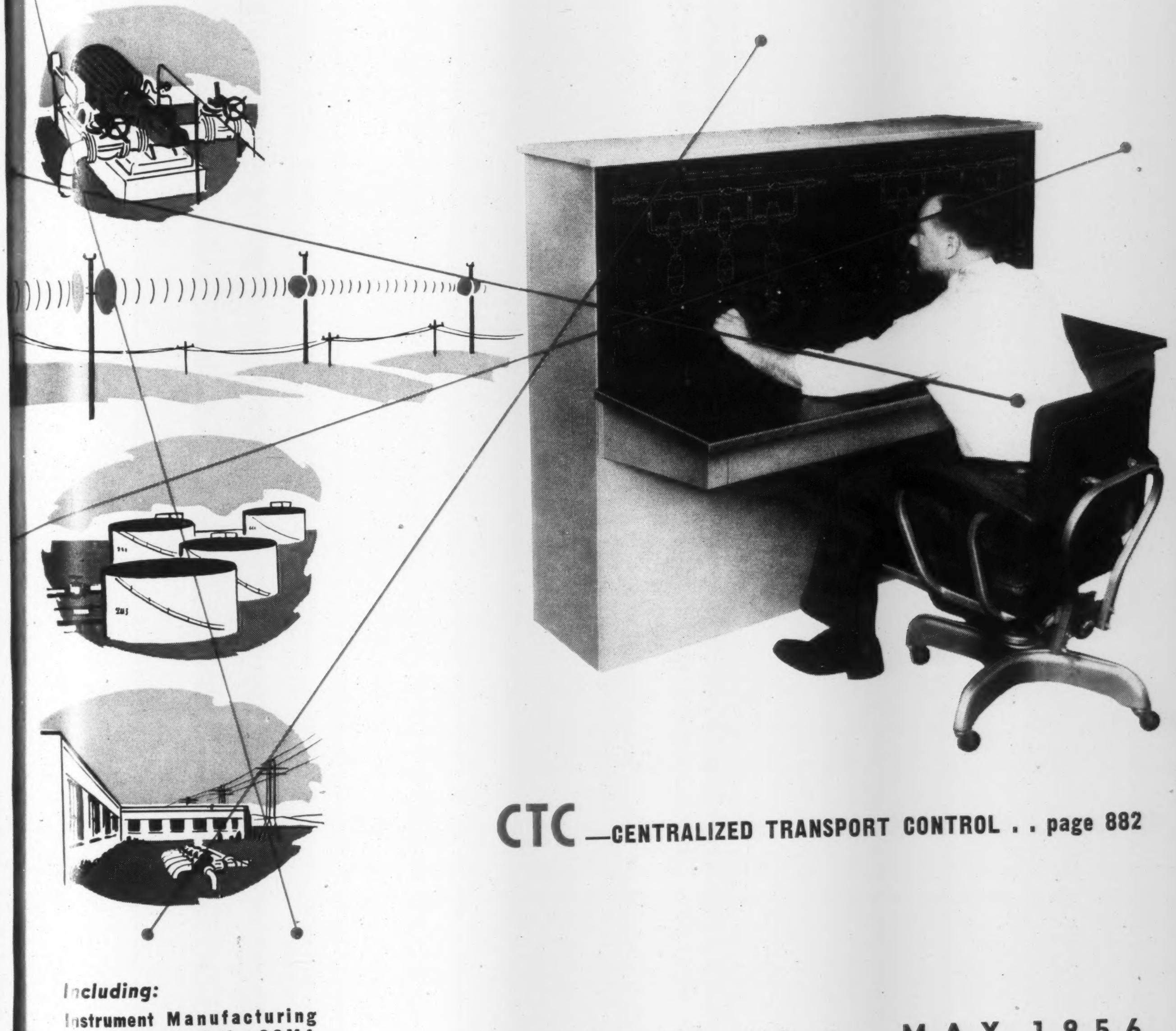

CTC —CENTRALIZED TRANSPORT CONTROL . . page 882

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VOLUME 29 NO. 5 **MAY 1956**

Here's The Most Versatile Pilot Ever Offered!

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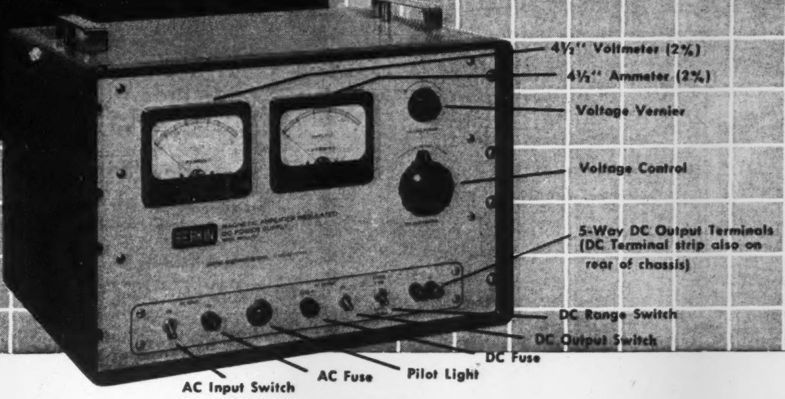
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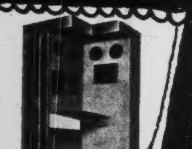

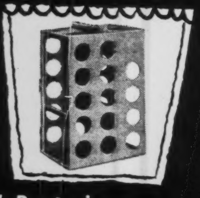

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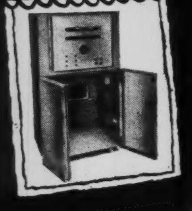

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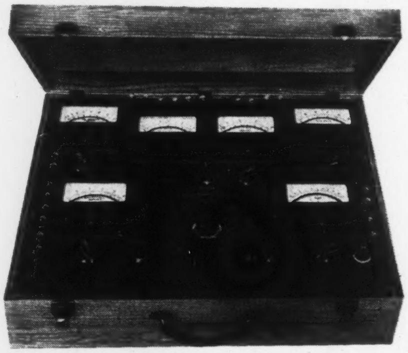

Designed to make a wide variety of magnetic measurements according to A.S.T.M., such as:
***Core loss testing* using Epstein specimens**
or standard E and I cores.
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Measurements of *Total Flux* of hard magnets.
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Six precision instruments enable this portable test set to make magnetic measurements with an overall accuracy of 1%.

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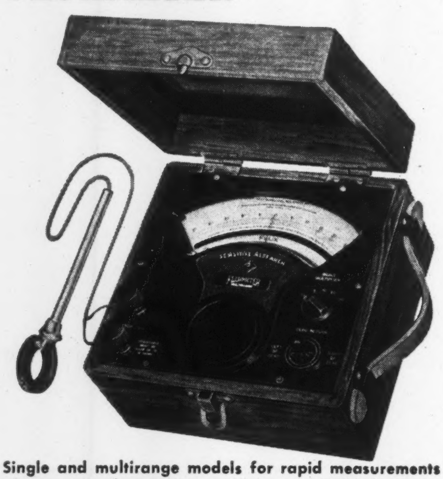

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MAY 1956

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL FOR 28 YEARS — SINCE JANUARY 1928

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here's new convenience, new economy in positive leak detection...

Consolidated's new type 24-210 leak detector

Everything offered by previous CEC Leak Detectors . . . *plus* new simplicity, new convenience, and a startlingly low price. That's the story in a nutshell of Consolidated's new Type 24-210 Leak Detector, newest instrument from the company that made mass-spectrometer leak detection practical. It's usable wherever perfect seals are essential in the production of electronic components, in testing glass-to-metal seals, checking welded or soldered joints, locating or determining the size of leaks in *any* evacuated or pressurized system. It is extremely simple to operate . . . just plug it in and start it; there is no extended pump-down period, and no special training or experience is needed.

In research, maintenance or production, to combat leaks safely, positively, and economically, check these features of the new 24-210 Leak Detector . . .

- **No cold trap, no charcoal trap** . . . requires no attention, no filling with refrigerants.
- **Positive interlocks** . . . to prevent instrument damage due to improper operation.
- **Highly sensitive** . . . detects one part of helium probe gas in 300,000 parts air.
- **Convenient** . . . all controls on front panel; all electronic components readily accessible.
- **Highly simplified** . . . etched circuits for compactness and reliability; only six tubes in entire chassis.
- **Compact and portable** . . . measures only 18½" wide x 22" deep x 20½" high; weighs only 145 lbs . . . perfect for bench-top operation; plugs into 115-volt, 60-cycle line.
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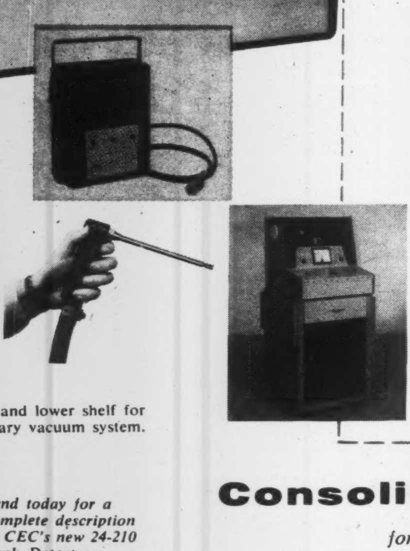
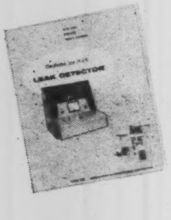
- **Low cost** . . . achieved through advanced design; quality, dependability maintained at highest level.



Accessories to increase the 24-210's convenience and usefulness include: Sampling Probe (right) for pinpointing leaks in pressurized systems; Audio Alarm (above right) which provides audible signal whose pitch varies with the size of the leak; Mobile Workstand (extreme right) which carries instrument, provides work table, drawer facility, and lower shelf for mounting auxiliary vacuum system.



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INSTRUMENTS and AUTOMATION

Letters to the editor

Editor, I&A:

In your November 1955 issue of *Instruments and Automation*, on page 1804, I found a nice picture of the graphic panel installed by our Belgian company at Societé Industrielle Belge des Petroles in Antwerp.

As regards the notation that the colorgraphic control panel is believed to be the first of its kind to be used in a European refinery, I would like to mention that in this country 21 graphic panels have been installed from 1952 to date.

One of these graphic panels is that of Europe's largest control room at the T.C.C. plant of Socony-Mobil-Oil Co. of Naples. Another graphic panel at the Leghorn refinery of ESSO-Standard for a hydroforming unit is, we believe, the largest graphic panel existing in Europe.

The first graphic panel that we installed in this country was a 15-ft long panel for RA.SI.O.M. in Augusta (Sicily) for a Topping and Stabilizing Unit; its installation dates back to December 1952.

Out of the 21 graphic panels installed, 18 have been designed, engineered and built in this country on American standards making use of U.S. made instruments.

R. Gavazzi
Minneapolis-Honeywell Regulator Co.
Milan, Italy

We are pleased to set the record straight, to acknowledge the pace of European instrumentation, and to note the gratifying use of American-made instruments.

Editor, I&A:

As a subscriber to *Instruments & Automation* I have been following the current series of articles on Control Valves by C. S. Beard.

Mr. Beard appears to be well versed in his subject and the articles have been well written, making for very interesting reading. As a matter of fact, I find your editorial coverage of the Process Industries and its' related control equipment to be extremely worthwhile and valuable.

However, my purpose in writing to you is to try to correct an obvious oversight and definite mis-statement in Mr. Beards' article (Control Valves #2) which appeared in your February issue.

Under the sub-title "Flow Capacity" Mr. Beard states, "As a Venturi section has the least pressure loss of any engineered obstruction, it would seem that a valve designed with a variable Venturi throat would have the greatest flow capacity." In this portion of his statement we find no fault. But in his next sentence he states "This is true, but the mechanical difficulty and the necessity for obtaining other control characteristics have precluded this approach to valve design."

It is with this latter part of Mr. Beards' observations that we find fault. He has completely overlooked the P-K Paul Valve which incorporates all of the desirable features he claims are precluded by design difficulties.

The P-K Control Valve is a Venturi section body design. As a result our valve does have considerably higher capacity than conventional single and double ported, restricted flow valve bodies.

For a capacity comparison please refer to Table 2.2 of this same article: "C_v of various sized valves of various manufacture." Mr. Beard lists value sizes and C_v ratings of eight control valve manufacturers. These are obviously double-ported valve capacities, although there is no indication of this. C_v ratings of single-ported valves of the same manufacture are considerably less.

C_v (Capacity Coefficient)

Valve size	Manufacturer F Double-Ported Valves*	P-K Industries Single-Ported Valves Nominal Capacities
1"	17	20
1½"	39	45
2"	61	80
2½"	98	125
3"	150	180
4"	219	320
6"	500	720
8"	700	1280

* Single-Ported Valves Manu. F approximately 25% less.

For your comparison we list below the P-K capacity ratings against those of Manufacturer F (who has the highest capacities of the group listed in table 2.2).

The relative unbalanced force for a P-K Paul Control Valve is only 25 to 33% of the unbalanced force of a standard single-ported globe-type valve body.

P-K Industries is a relatively new company in this field, having been organized only two years ago. However, the basic valve design has been in use for a number of years. . . . This equipment will be displayed at the 3rd International Automation Exposition.

Herman L. Paul, Jr.
Chief Engineer
P-K Industries, Inc.
N. Arlington, N. J.

Chet Beard did not completely overlook the P-K Paul. He showed it in Fig. 3-35 and brought out the advantages of its ball seat. He replies to Mr. Paul as follows:

My statement that a Venturi section would make an excellent valve if it could be manipulated to cause throttling assumed that the throttling would be obtained by a uniform increasing and decreasing of the throat, somewhat like the variation in the opening of a lens, instead of by inserting a ball (*I&A*, Fig. 3-25, page 502, March, 1956) or even a plug (Figs. 3-9, 3-21, 3-24, or 3-25 of the same issue).

Mr. Paul calls attention to higher C_v factors obtained with the P-K valve as compared to the table on page 283 of the February issue. This is to be expected because, although the notes failed to explain, the table lists capacities of equal-percentage plug and V-port top- and bottom-guided valves. The pinch valve, plug cock, ball valve and others which open to allow "straight through" flow will allow greater open-flow capacities.

C. S. Beard

Editor, I&A:

Can you help me with this problem? I am field engineer in instrumentation. When a plant is being constructed, I assist in instrument installation and startup. This involves training men on the job. Then when the plant is in operation, I lose the best men to the purchasing company. I can't carry a crew to the next job without premium pay for them. Will

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CATALOG R2

The latest attempt of the catalog compilers to keep up with the expanding line of AMPHENOL *rack and panels is the new R2. Micro-Ribbons are fully described in this authoritative manual.*

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AMPHENOL

LETTERS—CONTINUED

appreciate any "angles" you suggest for this situation.

D. V. Stipp
Ukiah, Calif.

Good men are always hard to retain—especially when the company that needs them knows where they are. Your answer is that your instrument men should be paid this premium pay. They obviously are worth it.

Editor, I&A:

Re Inquiry A-63, page 397 of the March 1956 issue, your correspondent might be interested in a recent article on the subject: "Measurement of Transient Power and Energy Dissipated in Closing Switch Contacts," by W. B. Ellwood, *Bell System Technical Journal*, November, 1955. This has also been reprinted in *Bell Monograph No.* 2518.

B. G. Doutre
Telecommunications
Laboratory Engineer
Trans-Canada Air Lines
Montreal, Quebec

This comment has been forwarded to the inquirer, along with other clues for his consideration. We print this letter to show how readers as well as instrument manufacturers come to the aid of men with instrument problems. Thank you, Mr. Doutre, for taking your time to assist a fellow engineer with a problem.

Editor, I&A:

(Please enter) a subscription to *Instruments and Automation* via *Airmail* from January 1956 to December 1956. Price . . . *$90.00.* Please send the back issues at the earliest possible time.

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Editor, I&A:

I like your page entitled "Trends" in *Instruments and Automation.* It reminded me a little bit of the *Farm Journal* at first, but it certainly comprises a lot of interesting information into convenient and readable form.

George Gardner
Scotia 2, N. Y.

← Circle **6** on inquiry card.

Editor, I&A:

I would like to thank you for your magazine, that reaches me at regular intervals. I consider that it is very instructive and can only have some of the best instrument and automation minds behind it to enable such a great magazine to be produced, month after month, without the slightest sign of falling off.

J. H. Spruce, Esq.
Newton, Frodsham
Chesire, England

If England is full of such considerate and appreciative engineers it must be a delightful country.

Editor, I&A:

Somehow I feel that the editorial "Do You Know Your Instruments?" [March, *I&A*] lacks direction in some respects. It is agreed that the more knowledge about instruments a technician or engineer has, the better, and all will be useful some time. Some discussion on specific applications of the knowledge seems needed.

Your fourth point on performance I concur in heartily as knowledge needed by all instrument engineers and technicians on all instruments they develop, test or use.

On the other four points I am not so sure. An instrument engineer developing or testing instruments is often compelled to use components at hand, in which case the four-point knowledge is useful, possibly essential. This application is essentially a laboratory operation.

In instrumenting a production process, I suspect that major adaptation is less useful; minor adaptation, as needed, is covered by the manufacturer's instructions. It will prove cheaper in the long run to buy components specifically for an installation than try to do a major adaptation. Using the services of specialists is superior to the "handy man" approach.

However, there is an important exception to the situation outlined in the foregoing paragraph. Sometimes instrumentation cannot be bought for the application. Then adaptation information may prove valuable and may be the only solution. Even here it may prove cheaper to call in a selected instrument manufacturer to do the job.

W. G. Brombacher
National Bureau of Standards
Washington, D.C.

Editor, I&A:

The editorial that you wrote in the March issue "Do You Really Know Your Instruments?" is applicable to maintenance men who have to *live* with the instruments, and in emergency reach for wild straws requiring immediate substitutions. For them, the editorial has merit and thought.

In our case, and others like us, the approach is different. Our job is to select instruments to satisfy a specific application. The instrument is to be of quality merchandise; be reliable and accurate; reasonable in price; and readily available.

Our selection of instruments may be influenced in some instances by our customer preferences whose dictates are based on existing instruments. The customer desires to keep spare parts to a minimum and to lessen the burden on the instrument repair group who will not have to familiarize themselves with new instruments.

Joseph Conison
Instrument Engineer
The Fluor Corporation
Los Angeles, Calif.

Both Mr. Brombacher and Mr. Conison have detected a weakness in our editorial. It implies that instruments should be developed by gadgeteering. We agree—indeed our entire book is devoted to the major proposition—that the instrument required should be bought, not built, if at all possible. But a thorough, piece by piece, analysis of instruments already in your stockroom and on your shelves might have the beneficial results that (1) problems for which no existing instrument is specifically designed might become less formidable, (2) you can find new uses for the existing instruments, and (3) you will "really" know your instruments. We have observed in the past that one difference between an outstanding instrument man and his less successful fellow instrument man is that the former really knows his instruments, inside and out. The editorial was meant to show how little was known about one phase of instrumentation, to stimulate interest about the "guts" of equipment and, perhaps, to suggest one phase (but just one phase) of an educational program for an instrument department. The major theme was that existing instruments are more powerful than commonly realized.

Editor, I&A:

We believe the ideas expressed in your editorial "Do You Really Know Your Instruments" are of prime importance to all Instrument Engineers

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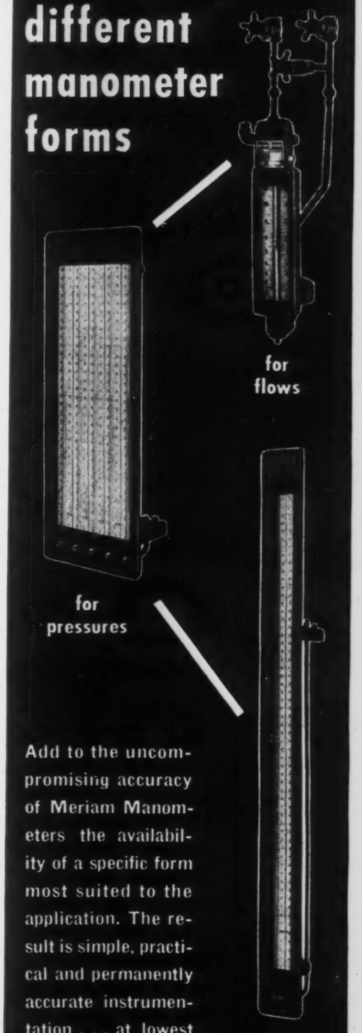

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AMPHENOL

LETTERS—CONTINUED

appreciate any "angles" you suggest for this situation.

D. V. Stipp
Ukiah, Calif.

Good men are always hard to retain—especially when the company that needs them knows where they are. Your answer is that your instrument men should be paid this premium pay. They obviously are worth it.

Editor, I&A:

Re Inquiry A-63, page 397 of the March 1956 issue, your correspondent might be interested in a recent article on the subject: "Measurement of Transient Power and Energy Dissipated in Closing Switch Contacts," by W. B. Ellwood, *Bell System Technical Journal,* November, 1955. This has also been reprinted in *Bell Monograph No.* 2518.

B. G. Doutre
Telecommunications
Laboratory Engineer
Trans-Canada Air Lines
Montreal, Quebec

This comment has been forwarded to the inquirer, along with other clues for his consideration. We print this letter to show how readers as well as instrument manufacturers come to the aid of men with instrument problems. Thank you, Mr. Doutre, for taking your time to assist a fellow engineer with a problem.

Editor, I&A:

(Please enter) a subscription to *Instruments and Automation* via *Airmail* from January 1956 to December 1956. Price . . . *$90.00.* Please send the back issues at the earliest possible time.

Shell Refinery (Australia) Ptry. Ltd.
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This $90.00 subscription comprises $6 for subscription plus $84 for airmail postage. When the Australians see something good they want it FAST.

Editor, I&A:

I like your page entitled "Trends" in *Instruments and Automation.* It reminded me a little bit of the *Farm Journal* at first, but it certainly comprises a lot of interesting information into convenient and readable form.

George Gardner
Scotia 2, N. Y.

← Circle **6** on inquiry card.

Editor, I&A:

I would like to thank you for your magazine, that reaches me at regular intervals. I consider that it is very instructive and can only have some of the best instrument and automation minds behind it to enable such a great magazine to be produced, month after month, without the slightest sign of falling off.

J. H. Spruce, Esq.
Newton, Frodsham
Chesire, England

If England is full of such considerate and appreciative engineers it must be a delightful country.

Editor, I&A:

Somehow I feel that the editorial "Do You Know Your Instruments?" [March, *I&A*] lacks direction in some respects. It is agreed that the more knowledge about instruments a technician or engineer has, the better, and all will be useful some time. Some discussion on specific applications of the knowledge seems needed.

Your fourth point on performance I concur in heartily as knowledge needed by all instrument engineers and technicians on all instruments they develop, test or use.

On the other four points I am not so sure. An instrument engineer developing or testing instruments is often compelled to use components at hand, in which case the four-point knowledge is useful, possibly essential. This application is essentially a laboratory operation.

In instrumenting a production process, I suspect that major adaptation is less useful; minor adaptation, as needed, is covered by the manufacturer's instructions. It will prove cheaper in the long run to buy components specifically for an installation than try to do a major adaptation. Using the services of specialists is superior to the "handy man" approach.

However, there is an important exception to the situation outlined in the foregoing paragraph. Sometimes instrumentation cannot be bought for the application. Then adaptation information may prove valuable and may be the only solution. Even here it may prove cheaper to call in a selected instrument manufacturer to do the job.

W. G. Brombacher
National Bureau of Standards
Washington, D.C.

Editor, I&A:

The editorial that you wrote in the March issue "Do You Really Know Your Instruments?" is applicable to maintenance men who have to *live* with the instruments, and in emergency reach for wild straws requiring immediate substitutions. For them, the editorial has merit and thought.

In our case, and others like us, the approach is different. Our job is to select instruments to satisfy a specific application. The instrument is to be of quality merchandise; be reliable and accurate; reasonable in price; and readily available.

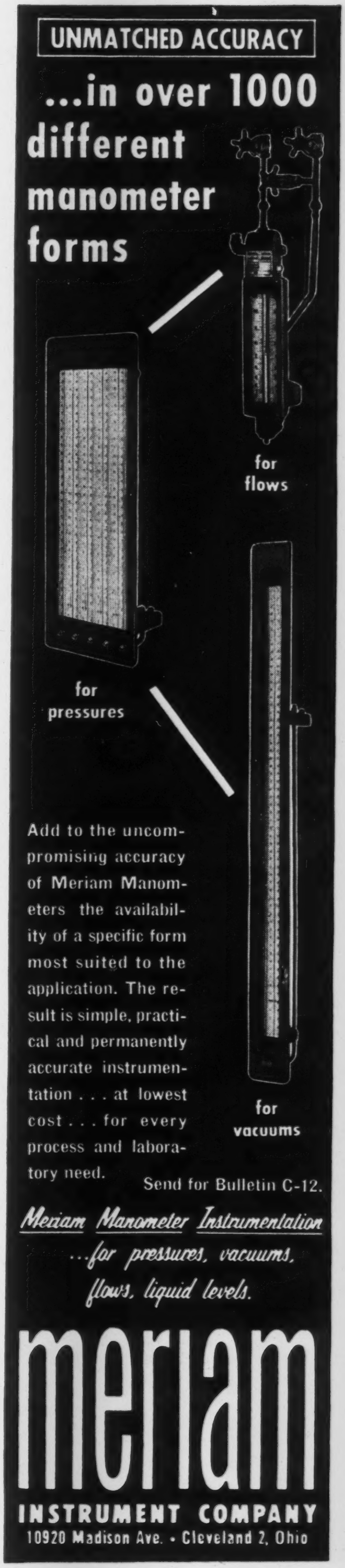
Our selection of instruments may be influenced in some instances by our customer preferences whose dictates are based on existing instruments. The customer desires to keep spare parts to a minimum and to lessen the burden on the instrument repair group who will not have to familiarize themselves with new instruments.

Joseph Conison
Instrument Engineer
The Fluor Corporation
Los Angeles, Calif.

Both Mr. Brombacher and Mr. Conison have detected a weakness in our editorial. It implies that instruments should be developed by gadgeteering. We agree—indeed our entire book is devoted to the major proposition—that the instrument required should be bought, not built, if at all possible. But a thorough, piece by piece, analysis of instruments already in your stockroom and on your shelves might have the beneficial results that (1) problems for which no existing instrument is specifically designed might become less formidable, (2) you can find new uses for the existing instruments, and (3) you will "really" know your instruments. We have observed in the past that one difference between an outstanding instrument man and his less successful fellow instrument man is that the former really knows his instruments, inside and out. The editorial was meant to show how little was known about one phase of instrumentation, to stimulate interest about the "guts" of equipment and, perhaps, to suggest one phase (but just one phase) of an educational program for an instrument department. The major theme was that existing instruments are more powerful than commonly realized.

Editor, I&A:

We believe the ideas expressed in your editorial "Do You Really Know Your Instruments" are of prime importance to all Instrument Engineers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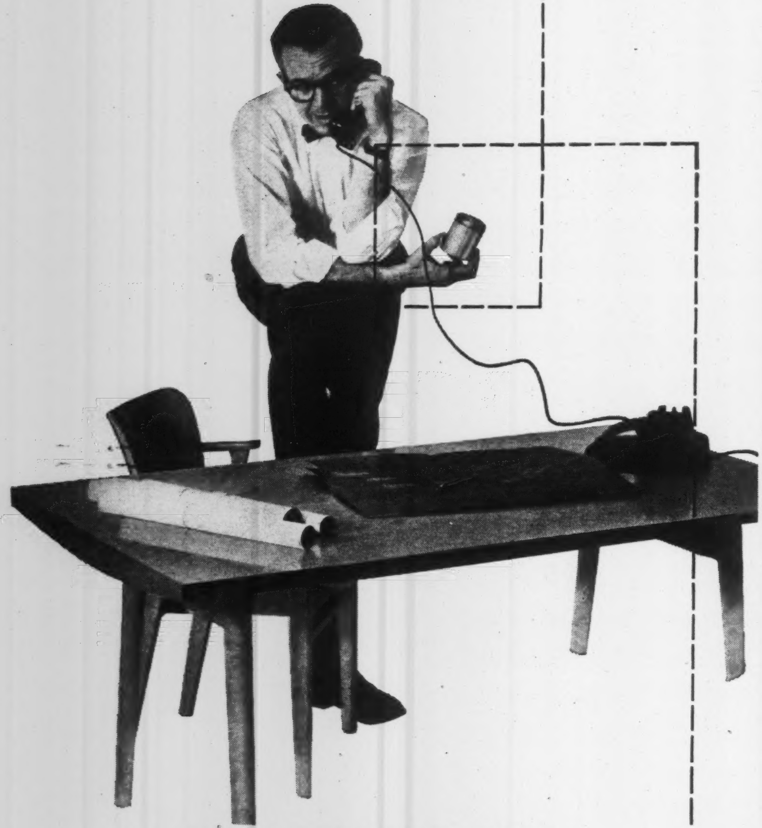

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LETTERS—CONTINUED

and Instrument Specialists in an industrial organization using relatively large quantities of industrial instruments.

We have found it necessary many times to analyze instrument equipment such as you have done in your editorial in order to adapt all or parts of it for some purpose other than that for which it was specifically designed. This has been done at the expense of considerable time on the part of our Instrument Specialists. I believe it would be a help to many users of instrumentation if more pertinent technical data of the type you mentioned were available from the manufacturers of these instruments.

F. S. Becker
Chief Instrument Engineer
Sun Oil Company
Marcus Hook, Pa.

Editor, I&A:

I do not believe that Mr. Hawkins and I are in serious disagreement; rather, we have only to reach an agreement on definitions. My training in classical mathematics is not extensive, but I have learned that without precise definitions all is lost. In scientific work and in scientific writing, to allow "usage" to broaden, modify, or befog a definition may be to allow a sharp tool to become dull.

Mr. Hawkins is correct in stating that a system which involves counting of pulses is digital. In such a system there must be a device or component which decides when the change in the data is sufficient to require an increase or decrease of the count by one unit. This device is a "quantizer" or "digitizaler," and the minimum change in the information which causes the count to be changed by one unit is the interval of quantization. Thus, quantization of input data is not just "important" or "desirable," but is the heart of a digital process. In a digital system the number of pulses is the significant item, their amplitude carries no information and is standardized for convenience.

Analog systems may be of two kinds, continuous or discrete. In a discrete analog system pulses also are present; each sample of the data gives a pulse. These pulses are not significant in their number, but in their amplitudes, and the pulse-to-pulse change is not quantized. Such systems are discussed in "Digital Auto-

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versatility

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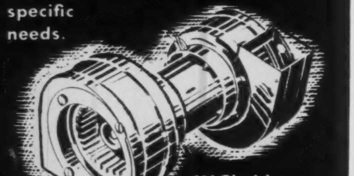

IMC's blowers are found in combination with the company's motors, in an impressive array of industrial and military equipment. Standard IMC motor-blower units are readily adaptable for high ambient temperature operation, and are impregnated for protection in humid atmospheric situations.

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For more information circle **10** on inquiry card.

LETTERS—CONTINUED

mation—No. 6" in the March issue of I&A, and are illustrated there by Figures 6-1 and 6-2. The word "discrete" seems proper here. The essence of my point is that some people have loosely called such systems "digital" simply because they use pulses. This usage can only lead to confusion.

A. C. Byers
Chief, Electronics Section
The Franklin Institute
Philadelphia, Penna.

In the Jan. issue of I&A, Mr. Byers pointed out that "discrete" and "digital" have different meanings. Mr. Hawkins replied (in our March issue) that the only basic division is between "analog" and "digital." Mr. Byers replies here that you can have discrete-pulse-type analog systems. Both Mr. Byers and Mr. Hawkins agree that any system in which signal AMPLITUDE (including pulse amplitude) is the variable is an analog system; any system in which the NUMBER of pulses is the variable is a digital system.

Editor, I&A:

As a subscriber of many years standing, I would strongly urge that, in keeping with the practice of most good technical journals, *Instruments and Automation* include with the author's name an address at which he may be reached; I have heard several other readers in my immediate community express the same wish.

May I take this opportunity to express my general satisfaction at the way in which *Instruments and Automation* has developed over the past several years? The editorial board are certainly to be congratulated on the success which they have had in turning out an excellent technical magazine.

Joseph R. Crump
Prengle Dukler & Crump
Houston 2, Texas

Most authors prefer us to forward correspondence. We will give you the addresses of any authors you wish to contact—or forward your correspondence.

Editor, I&A:

In the November, 1955, issue of your excellent magazine there was an article on page 1930 on "Digital Automation" by Messrs. Klein, Williams and Morgan.

I was much impressed by the discussion in this article and the extreme clarity of presentation. I reviewed it with my daughter who is a junior in high school and who is interested in the general operation of code arithmetic.

I will appreciate it if you can supply me with two copies of reprints or tear sheets of this article since I feel that her mathematics instructor in high school will also be interested in this discussion. He has been using items of this type in an advanced mathematics discussion group.

Ralph E. Meints
Vern E. Alden Co.
Chicago, Ill.

"Extreme clarity of presentation" is a characteristic of this entire series, which opens the doors to all aspects of digital techniques—code arithmetic, matrices, multiplexing, etc., etc.

Editor, I&A:

I am writing concerning the article, "Automation and Economics—A Counterattack on Anti-Automation Propaganda." I am in agreement with your article for the following reasons:

We are approaching the age when production will lag the nation's demands. Recent developments in the field of automatic controls and electronics have contributed greatly to this inevitable era and promises an increase in the economic stability of our country. Progress, the result of science, must manifest itself and this phenomena must exist to improve human activity.

I agree that in the long run automation will create more jobs and higher wages. I believe automation is not a second Industrial Revolution as some declare. It's actually another step in the continuing industrial revolution, which caused such a stir when the power loom was introduced in England in the mid-eighteenth century. Experience has proven that anything which increases the productivity of the human worker both raises the standard of living and creates more opportunities for employment.

Paul J. Yajko
Leechburg, Penna.

Yes indeed—but we have carefully and repeatedly emphasized the point out that the economic health of our economy as a whole rests on many pillars, including federal fiscal policy, federal expenditures, wage/price ratios, etc., etc. Progress and prosperity are by no means "inevitable," even via automation. The danger of equating present or future prosperity with automation is

that automation will be blamed for the depression or recession that would inevitably follow poor management of our economy. Automation can indeed result in high productivity—but high productivity by no means assures prosperity, it merely makes the prosperity more enjoyable to all via lots of goods at cheap prices. The real *causes* of prosperity must be sought in the many factors that establish the purchasing power of our populace, including wages, stock dividends, and profits.

Editor, I&A:

I am a student of Electrical Engineering (electronics major) at The Milwaukee School of Engineering.

Instruments and Automation is the first publication I have found that contains articles that are not so basic as to be boring and yet not so theoretical they can not be understood by the novice engineer. I am sincerely glad I have a subscription.

Charles A. Turner
Milwaukee 4, Wisc.

We'll give odds that this "novice" develops into a first class engineer in a hurry. He observes and evaluates—essential engineering characteristics.

Editor, I&A:

Just spent a happy Sunday afternoon with your January and February issues.

The "Letters to the Editor" give one a feeling of looking over your shoulder—a personal touch that creates a contact between reader and editor.

However, there is one thing I would suggest that would add substantially to the reader's appreciation of *Instruments & Automation*. That is, I think you should run a block in which you list the recent articles you've had in certain very important fields. In short, you should give the readers a continuous, running summary of your coverage in important, basic fields.

H. Olken
Arndt-Preston-Chapin-Lamb & Keen, Inc.
Philadelphia, Pa.

A very good idea. *I&A* is already the best-indexed publication in our field, owing to the careful indexing of the extensive New Instrument and New Literature listings. The next step is to index the articles as suggested. We will try to do this starting in an early issue. The only drawback is space.

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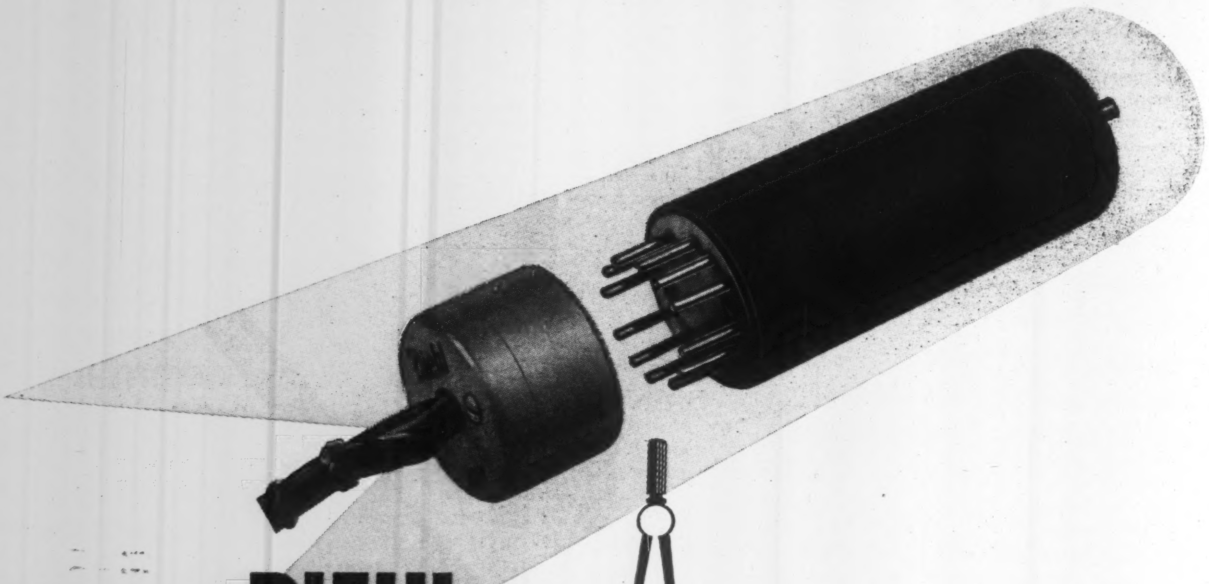

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. . . a new low in total functional error for a Size 11 Resolver—0.05%! An entirely new design concept permits complete machine-winding of the units, with resulting high uniformity of product and performance. Other novel design features enable the resolver to withstand altitudes of 70,000 feet without pressurization.

There are three types . . . *with high impedance,* permitting the primary to be excited with 110 volts at 400 cycles . . . *with low impedance,* when higher frequency response is desirable . . . and *compensator wound* for temperature and frequency variations.

These types are obtainable, each with 2 input and 2 output windings, in either Class I Design with 0.05% maximum total functional error or Class II Design with a maximum error of 0.10% where less accuracy is tolerable and lower cost is desired.

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Type	Low Impedance	High Impedance	Compensator Wound	
Total Functional Error	0.05%	0.05%	0.05%	
Input Impedance (ohms)	750/80°	3000/80°	1500/78°	±10% on ohms ±2° on angles
Effective Resistance (ohms)	3,000	12,000	5,500	when resonated
Transformation Ratio	0.975/6°	0.975/6°	0.975/6°	±0.02 on ratio ±1° on angle
Max. Null Voltage (m. v./volt input)	1.0	1.0	1.0	Quadrature
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Case and shaft supplied with reference markers.

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Electrical Division of THE SINGER MANUFACTURING CO.
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IA 5-56

For more information circle 12 on inquiry card.

INSTRUMENTS and AUTOMATION Inquiries

The inquiries below were received from subscribers to **Instruments and Automation.** In most instances an answer has been sent, but we shall be glad to forward the name and address of the inquirer if you have any further suggestions.

Miniature Ball Bearings

Project engineer in company manufacturing test equipment would like to contact "Micro-Tech," manufacturers of miniature ball bearings whose address could not be found. A-82

Switch Dial Testing Set

Purchasing Agent in telephone company seeks source of Peerless switch dial testing set T-2000 which needs repair. A-83

Hygrometer Elements

Manufacturer of precision parts seeks source for a spiral-type element which will curl or uncurl with a relative change of moisture in air. Delivery on presently imported cellulose-type material glued to a bronze strip is unsatisfactory. A-84

Gas Meters

Canadian manufacturer desires names and addresses of U.S. manufacturers that produce positive-displacement domestic gas meters. A-85

Diffraction Gratings

Reader building a spectroscope wants quote on diffraction grating with 10,000 lines to an inch. A-86

Ultra-Centrifuge

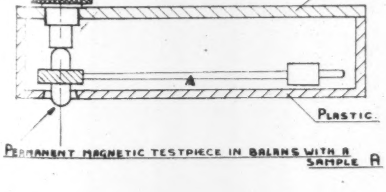
British import house wants Ultra-centrifuge, with photo camera, for measurement of molecular weights, for client. Range of revolutions: 18,000-60,000 rpm. A-87

Slip Rings

Chief Engineer of Test Lab seeks sources of supply for slip rings. A-88

Permeameter

Correspondent of Dutch company seeks manufacturer of illustrated permeameter, reputedly "Severn Engineering Co., somewhere in Maryland." A-89


A SAMPLES WITH AN PERMEABILITY OF 1,2; 1,6; 2 AND 2,6 μ.
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EBONIET.
A
PLASTIC.
PERMANENT MAGNETIC TESTPIECE IN BALANS WITH A SAMPLE A

Tape Recorder

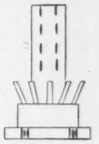
Reader seeks tape recorder usable for recording music and serving as dictating machine. A-90

Train-Induced Vibration

Export manager for railroad and public-works equipment seeks instruments for recording vibration effects of trains crossing bridges. A-91

Miniature Sockets

Manufacturer of power plant equipment seeks nine-pin miniature socket with 3 notches and 1½"-long ⅜"- dia. center (see illustration). A-92.



Induction Heating Unit

Distributor of electric supplies seeks induction heating unit for high-speed heat treatment of 6" x ½" steel specimen. A-93

Missing Company

Sales Department of Glass company is trying to locate company whose name includes the word "Quarter" such as "Quarter Corp." or "Quarter Mfg. Co." A-94

Platform Scale

Purchasing agent for city seeks bids on platform scale for weighing objects of up to 175 lbs with accuracy of 1/100 lb. A-95

Homogenizer

Importer of scientific instruments in France seeks manufacturers of two-speed homogenizer-macerator "Virtis" (23,000 and 45,000 rpm). A-96

Goniometer

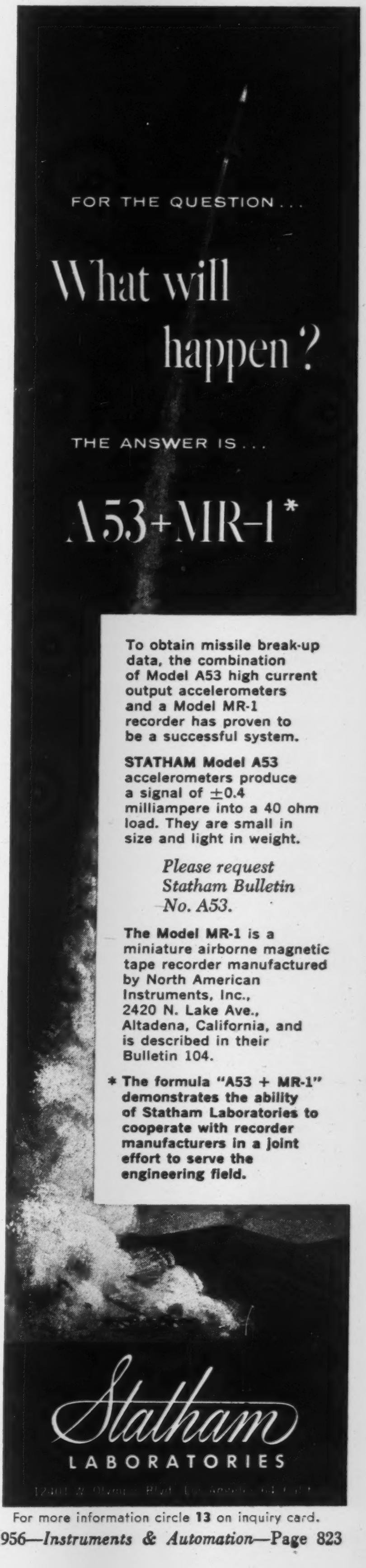
Supply house of scientific instruments seeks manufacturers of goniometers. A-97

Oil Testing Machine

British importer seeks "Oil Test Engine adaptable for research of lubricating qualities. If possible, a machine corresponding to the American-produced H5 Lauson." A-98

Specific Gravity Recorder

Large oil company is seeking a liquid specific gravity recorder for crude oils with an accuracy of 0.1° API gravity. A-99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What will happen?

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To obtain missile break-up data, the combination of Model A53 high current output accelerometers and a Model MR-1 recorder has proven to be a successful system.

STATHAM Model A53 accelerometers produce a signal of ±0.4 milliampere into a 40 ohm load. They are small in size and light in weight.

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The Model MR-1 is a miniature airborne magnetic tape recorder manufactured by North American Instruments, Inc., 2420 N. Lake Ave., Altadena, California, and is described in their Bulletin 104.

*** The formula "A53 + MR-1" demonstrates the ability of Statham Laboratories to cooperate with recorder manufacturers in a joint effort to serve the engineering field.**

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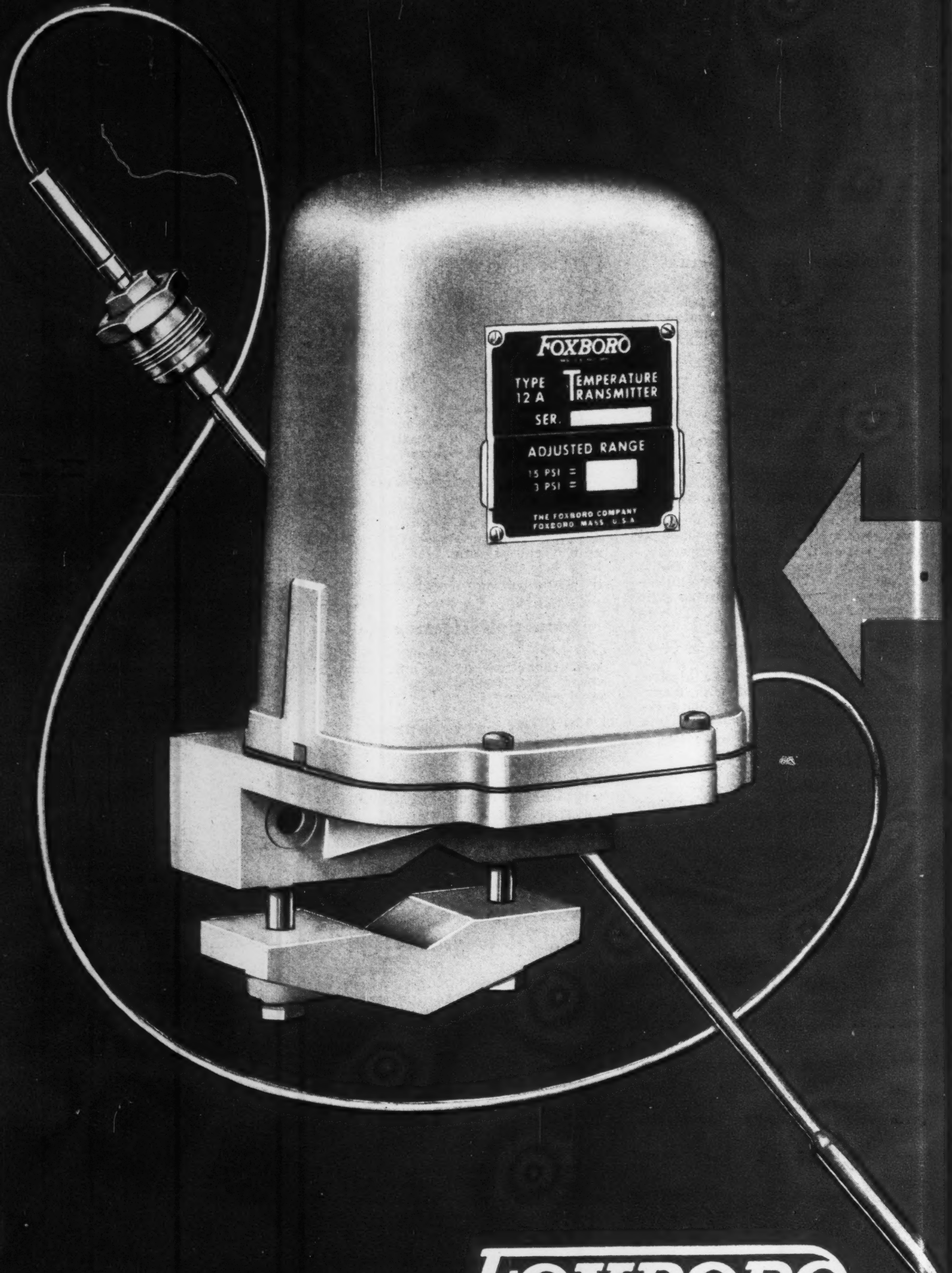
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There is no easier, simpler way to measure remote temperatures, *fast*, over so wide a range, with such high sustained accuracy, and at so low a cost!

Between the limits of —100°F. and +1000°F., with operational spans of 50°, 100°, 200°, and 400°F, this rugged, highly responsive instrument performs outstandingly under the most severe conditions. It is compensated for ambient temperatures and pressure. Derivative action can be furnished for optimum performance when substantial thermal or transmission lags exist.

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LEWIS

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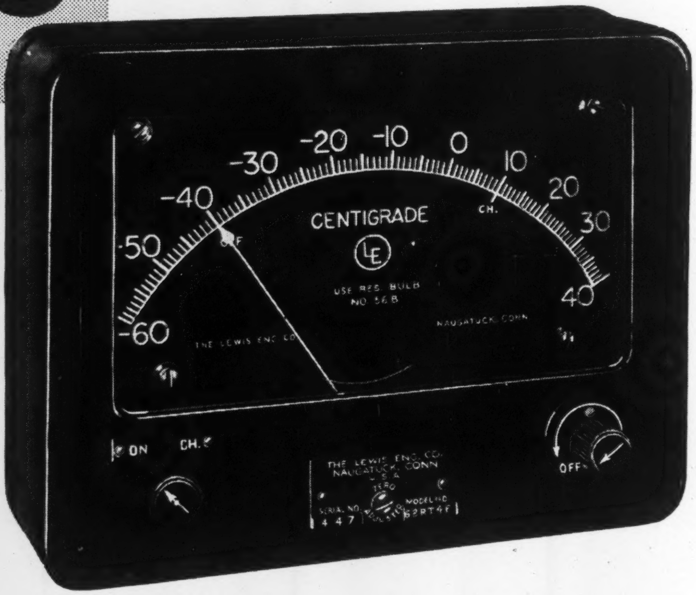
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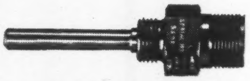
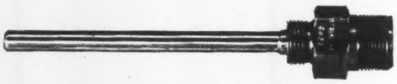
2" SIZE TO 4 POINTS

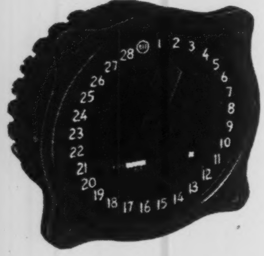


THREADED "AN" TYPE

3" SIZE TO 20 POINTS



THREADED "AN" TYPE



4" SIZE TO 28 POINTS

BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

Lewis Resistance Bulbs are adaptable for use with the 62RT4F Resistance Thermometer or with standard aircraft panel indicators. Special purpose bulbs with stem variations or for high temperature applications are available.

We invite inquiries on your temperature measuring problems.

THE LEWIS ENGINEERING CO.

Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

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INSTRUMENTS and AUTOMATION Trends

Transistor sales in 1955 were 3,646,800 units, nearly triple the 1,317,300 unit sales for 1954, reports RETMA. Value of sales in 1955 was $12,252,700, compared with $5,112,300 in 1954. Sales for 1956 are expected to exceed 10 million units.

Military TV is new and promising field, with equipment being developed for ground-ground and air-ground transmissions to command posts.

Transistor progress is dramatically revealed in following table which compares a 1954 transistorized superhet radio with its 1955 counterpart. Data are supplied by Texas Instruments, Inc., Dallas 9, Texas.

	1954	1955
Sensitivity	2000 μv/m	200 μv/m
Operating Voltage	22½V	6, 9, or 12V
IF Gain & Frequency	31db @ 262 kc	35db @ 455 kc
IF Output Capacity (C_{ob}) . . .	30-40 μμf	1 μμf
IF Neutralizing Capacity . . .	Selected	Fixed
Audio Output Power	20mw	250mw
Typical IF Transistor Price . .	$2.50	$1.75

New and growing field for technical work is computer programming. Programming engineers, also called information engineers, are already in short supply, and 15,000-20,000 will be needed in next ten years. These men need not be mathematicians--they merely set up the computer program.

Iron and Steel instrumentation will expand rapidly in 1956—steel companies plan to spend $1.2 billion on expansion in 1956 and to increase capacity by 5 million tons. Another $1.8 billion is planned for 1956-57, with capacity increasing by 5 million tons each year. Rate of expansion for past decade has been 3½ million tons per year. Present state of I&S Instrument art is revealed in newly published 100-page book "Automation in the Iron & Steel Industry," Instruments Publishing Company.

GE and its subsidiary Hotpoint have plans to enter domestic high-frequency-range field.

Pulp and paper industry is increasing rate of automation, is planning to spend $640 million in 1956 for expansion, says H. A. Sholl, Pulp and Paper Industry Mgr., M-H Regulator Co. Only 2% of this expenditure can fully automate industry, including high-speed data logging, scanning, and computing systems tied in with conventional instrumentation. Industry has pioneered use of radioisotopes.

Electronic printing (reproduction) is growing field, and includes processes of Xerography (Haloid), Smoke Printing (Standard Register), Electrography (Burroughs and others), and electromagnetic dry printing methods of GE, IBM, and others.

67.2% of all households in USA have 1 or more TV sets, 78.3% of all inside metropolitan areas, and 49.7% of all outside metropolitan areas.

An Engineer Speaks Out...

...about Design Testing of Complete Systems

As a design, analysis, and test center, the Servomation* Building Blocks offer the design engineer equipment that features exceptional flexibility and ease of operation. Servo control systems can be quickly mocked-up and tested, with the wide variety of standard servo components, external patch cord and jackboard connections, and the versatile Servoboard® and Servoscope® components of the Building Blocks. Closed loop characteristics can be predicted and pre-production "bugs" eliminated. The Building Blocks also allow you to change design parameters in the mechanical part of the system simply by rearranging or substituting components.

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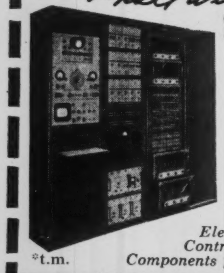
The Servomation* Building Blocks, as a design and test lab, have wide application in the development and synthesis of control systems of drone aircraft; control and guidance systems of guided missiles; and automatic airspeed and altitude controls. The Building Block computer components are available as 60 or 400 cycle units, and specifically packaged so that individual units can be installed as part of an airborne control system for preliminary flight tests before the final design is frozen.

For the full story on the Servomation* Building Blocks, please fill in your name and title in the section below. Attach it to your company letterhead and mail it to me.

Thos P Westover
Chief Control
Systems Engineer



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Please send me more information on Servomation* Building Blocks.

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Title...

For more information circle 16 on inquiry card.

INSTRUMENTS and AUTOMATION Events

For other computer Events see page 925.

June 3-8

Society of Automotive Engineers, Inc., Summer Meeting, Chalfonte Haddon Hall, Atlantic City, N. J. For information write Headquarters, 29 W. 30th St., New York 18, N. Y.

June 4-11

Materials Handling Equipment Distributors Association, 1st Annual Convention, Carter Hotel, Cleveland, Ohio.

June 5-8

Material Handling Exposition, Material Handling Institute, Inc., Public Auditorium, Cleveland, Ohio. For information write Material Handling Institute, Inc., 1 Gateway Center, Pittsburgh 22, Penna.

June 6-15

Motion and Time Study Course, sponsored by the AIIE and Society for Advancement of Management, Dept. of Industrial Engineering, Washington University, St. Louis 5, Mo.

June 6-8

American Society for Quality Control 10th Annual Convention and Exhibit, Palais Du Commerce, Montreal, Canada. For information write Charles R. Kendel, Lamson & Sessions Co., 1971 West 85th St., Cleveland 2, Ohio.

June 8-9

1st Symposium on Art of Glassblowing, sponsored by American Scientific Glassblowers Society. Corning Glass Center, Corning, N. Y. For information write ASGS, Box 784, Wilmington, Del.

June 10-15

Automation Seminar for Small Industries, Campus of Pennsylvania State University. For information write Louis H. Bell, Public Information Dir., Pennsylvania State University, University Park, Pa.

June 11-13

ASME Applied Mechanics Western Div. Conference, California Institute of Technology, Pasadena, Calif.

June 11-15

Symposium on Molecular Structure & Spectroscopy, Dept. of Physics & Astronomy, Ohio State University, Columbus 10, Ohio. For information write H. H. Nielsen, Ohio State University.

June 11-29

Process Control Theory (Summer Study Program), Case Institute of Technology. For information write Director of Special Programs, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

June 14-16

ASME Applied Mechanics Conference, University of Illinois, Urbana, Ill.

June 16-23

5th World Power Conference, Vienna, Austria. For information write Secretary, U. S. National Committee of WPC, Engineers' Joint Council, 33 W. 39th St., New York 18, N. Y., or Secretary, International Executive Council, WPC, 201-2 Grand Bldgs., Trafalgar Square, London, W.C. 2, England.

June 17-22

59th Annual Meeting, ASTM Technical Program & Apparatus Exhibit. Chalfonte-Haddon Hall, Atlantic City, N. J.

June 17-23

2nd Congress of the International Commission on ACOUSTICS, International Union of Pure and Applied Physics, New York, N.Y. For information write P. Fleury, Secretary General of IUPAP, 3 Boulevard Pasteur, Paris 15e, France.

June 18-22

4th Annual Human Engrg, Institute, Dunlap & Associates, Inc., 429 Atlantic St., Stamford, Conn.

June 18-24

"Automation" Meeting and Exhibition. French Association of Electronic Engineers, Paris, France. Please address all correspondence to Secretariat du Colloque sur l'Automatique, Chaire de Mechanique, Conservatoire National des Arts et Metiers, 292 rue Saint-Martin, Paris, (III°) France.

June 19-22

ASME Boiler & Pressure Vessel Committee Out-of-Town Meeting Held jointly with National Board of Boiler & Pressure Vessel Inspectors, Windsor Hotel, Montreal, Que., Canada.

June 25-27

Stanford Research Institute and University of California Symposium on "High Temperature—A Tool for the Future", University of California, Berkeley, Calif.

June 25-29

American Institute of Electrical Engineers, Summer & Pacific General Meetings, San Francisco, Calif.

July 9-20

Short Course in linear automatic control system synthesis, Purdue University, Lafayette, Ind.

July-16-27

Course in Modern Industrial Spectrography, Boston College, Boston, Mass. For more information write James J. Devlin, S.J., Physics Dept., Boston College, Chestnut Hill 67, Mass.

July 22-28

8th International Congress of Radiology, Mexico City, Mexico. For information write Jose Noriega, Tepic 126 (2e piso), Mexico, D.F. 7, Mexico.

July 23-27

Gordon Research Conference on Instrumentation, American Association for Advancement of Science, Calley Junior College, New London, N. H. For information write W. G. Parks, Dir., Gordon Research Conference, Dept. of Chemistry, University of Rhode Island, Kingston, R. I.

July 23-August 11

Wayne University Computation Laboratory, Summer Program, Wayne University, Detroit, Mich. For information write A. W. Jacobson, Dir., Computation Lab., Detroit 1, Mich.

August 19-24

6th International Symposium on Combustion, Yale University, New Haven, Conn. For information write Combustion Symposium, Mason Lab., Yale U., 400 Temple St., New Haven 11, Conn.

August 20-21

National Telemetering Conference, sponsored jointly by IRE, AIEE, IAS and ISA, Ambassador Hotel, Los Angeles, Calif. For information write D. M. Cullar, Farnsworth Electronics Co., 3702 E. Pontiac St., Ft. Wayne, Ind.

August 21-24

1956 Western Electronic Show and Convention, Pan-Pacific Auditorium, Los Angeles, Calif.

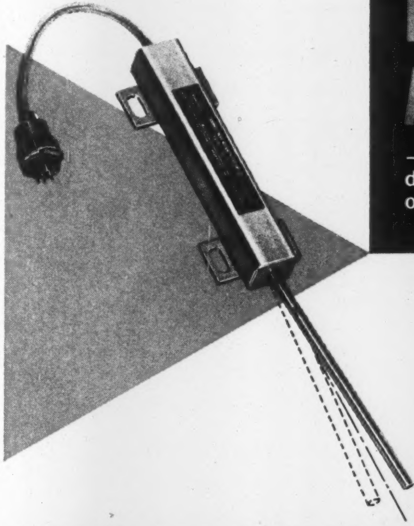
November 26-30

Third International Automation Exposition, New York Trade Show Building, 500 8th Ave., New York, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Penna.

SELF ALIGNING SHAFT—
linear motion
potentiometers

BOURNS ALIGN-O-POT*

—highly reliable
despite misalignment
of actuating member



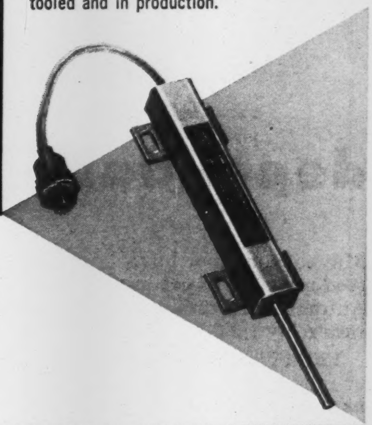
Here is a far-reaching advance in linear motion design. This unit allows for misalignment between the instrument and actuator—eliminating shaft side loads. With no alignment needed, the unit is mounted and installed quickly... is easily designed into a system.

To insure low noise characteristics under extreme vibration, the ALIGN-O-POT wiper assembly is supported throughout its entire travel by parallel guide rods. This provides continuous support directly at the point of contact... multiple contacts are used to further increase the reliability.

The ALIGN-O-POT has a stainless steel case and a flexible cable with plug connector. Standard travels are available from ½" to 6½". Other travels can be provided up to 36". The ALIGN-O-POT is fully tooled and in production.

BOURNS LINIOMETER®

high performance
under environmental
extremes



The LINIOMETER has a bushing-supported shaft and the same highly reliable internal construction as the ALIGN-O-POT—for use where the self-aligning feature is not applicable. Small cross-section and optional mounting configurations are added features of these units. Available in standard travels from ½" to 6½".

the complete line of linear motion potentiometers

Bourns offers a wide selection of standard instruments for any need from ⅛" to 36" travels—all built for maximum reliability and optimum performance. Bourns will work with you on special requirements.
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dependable relays for printed circuits

Maybe you, too, have been awaiting availability of a *good* relay for direct insertion into printed circuits. Now Automatic Electric can solve your problem with a miniature relay that is just right.

120 million operations, without a single readjustment or relubrication! That's what you get from this rugged, improved Series SQD Relay, because it features a special *heavy-duty* bearing and bearing pin. Also a recess in the bearing plate retains an adequate supply of lubricant for long-term lubrication of the bearing pin.

Consider these additional advantages:

1. The sections of the terminals that insert into the printed circuit board are NOT brazed or welded into place, but are integral parts of the coil terminals and contact springs—thus preventing internal loss in conductivity or continuity.
2. Terminal design permits direct plug-in of the relay into a printed circuit board, ready to be secured in place with any acceptable soldering technique.

Usually the desired contact spring combination, or pile-up, is sufficiently large so that additional mounting (support) of the relay is not necessary.

SQD Miniature Printed Circuit Relays are available with many different contact spring arrangements, and for a multitude of applications. Springs can be made of phosphor-bronze, "Bronco" metal, or other special-purpose materials, as required.

Of course the long life, heavy-duty features of the improved SQD Relay can be had in the conventional type of plug-in relay, if regular sockets are preferred for use, whether in printed circuitry or other applications.

To get complete details, write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Illinois. *In Canada:* Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

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Originators of the dial telephone • Pioneers in automatic control

GENERAL SYSTEM

For more information circle **18** on inquiry card.

Recommended Practice 7.1

Panhandle Pete

SOMEONE wrote me a letter about recommended practice 7.1. The writer of this letter kindly gave me permission to use it. He starts off as follows: "Gentlemen," and then he goes from there: "Over the years there have come to my home many interesting and humorous things via the mail. Up to now the Recommended Practices I have received have been useful and practical but the last one that came in, RP7.1, is a dandy. I have passed this RP7.1 around through the department for comment and we have come to the following conclusions which aren't likely to be the ones your people had in mind when they put RP7.1 in print.

1. Procedure 1.3.1 does not "locate a faulty line in a group of transmission lines unless you term the procedure under 2.1.3 precise work. We don't. You might just as well call out the lines as "Eeny, meeny, miney, moe" and go from there. Or you could say "Well I think it is that one, see?" and allow the laws of probability to take over. *"If no pressure is found then it is safe to assume that it is either the line under question or one not likely to be in service."* It is also safe to assume that 1. Maybe the line is plugged up. 2. Maybe the air reducing valve is broken, plugged up or set to zero on another line. 3. My gawd, ain't it hot to-day?

2. Under Procedures 1.3.2 and 1.3.3 we doubt if anyone goes out in the field and actually hunts air leaks. The usual thing is that one finds out his control doesn't operate right and that a leak in the lines could be a possibility, not the other way around.

3. Under 1.3.4, locating the leak, we liked this. We have just read and waded through a lot of hot air, built up a fancy test rig and when it comes right down to it, somebody still has to go out and paint the air lines with a soap solution just like we did back in grandpa's day. It is our opinion that all this great amount of—uh, I was going to say a naughty word here—this great amount of work by seventeen men of Aruba, three men at large, nineteen men on the Board of Review, and twenty three men on the Recommended Practice Committee could be boiled down into "To locate leaks, go over the air lines with paintbrush and soap solution."

4. Under 2.4.1 is described a beautiful set-up for producing ulcers. If you take all that tubing, gages and fittings shown in Fig. R.P.7.1.1 and connect it to what is described in 2.1.3 as "the line under question or one not likely to be in service" and try to maintain 17 psig against a blocked line, you've had it. We used to do this but we found that the test equipment leaked more than the "leak." Amphogel, by the way, is good for ulcers.

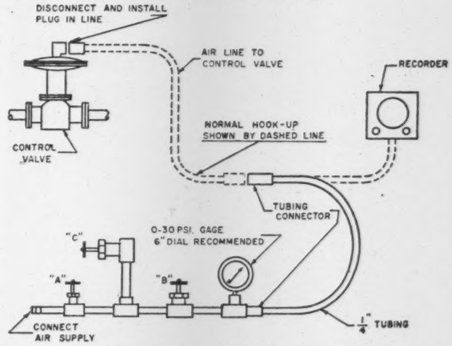
5. You don't mention the joys associated with locating a leak in tubing where the tubing is run through conduit.

6. Under 2.2.2 and 2.2.3 we think that rather than provide a means of modulating the air supply a better way to locate the other end of the line would be to connect a cylinder of N_2O to the one end of the line, send a man to the other end of the line and just let nature take her course. This way, we think the spirit of RP7.1 would be fulfilled besides making one man feel happy.

7. Our final conclusion, frankly, is that things are in a h— of a mess, and that this group of seventeen men from Aruba wrote this thing up while attending one of their beer parties. There's just no other explanation.

Panhandle Pete

ISA Recommended Practice RP 7.1
Pneumatic Control Circuit Pressure Test


DISCONNECT AND INSTALL PLUG IN LINE
AIR LINE TO CONTROL VALVE
RECORDER
CONTROL VALVE
NORMAL HOOK-UP SHOWN BY DASHED LINE
TUBING CONNECTOR
0-30 PSI. GAGE 6" DIAL RECOMMENDED
"C"
"A"
"B"
CONNECT AIR SUPPLY
$\frac{1}{4}$" TUBING

NOTE

INSTALL VALVE "B" SO THAT PACKING GLAND IS ON THE AIR SUPPLY SIDE AND NOT ON THE DOWNSTREAM (STATIC) TEST SIDE

$\frac{1}{4}$" PIPE FITTINGS & $\frac{1}{4}$" NEEDLE VALVES

DETAILS OF TEST RIG

FIG. RP 7.1.1

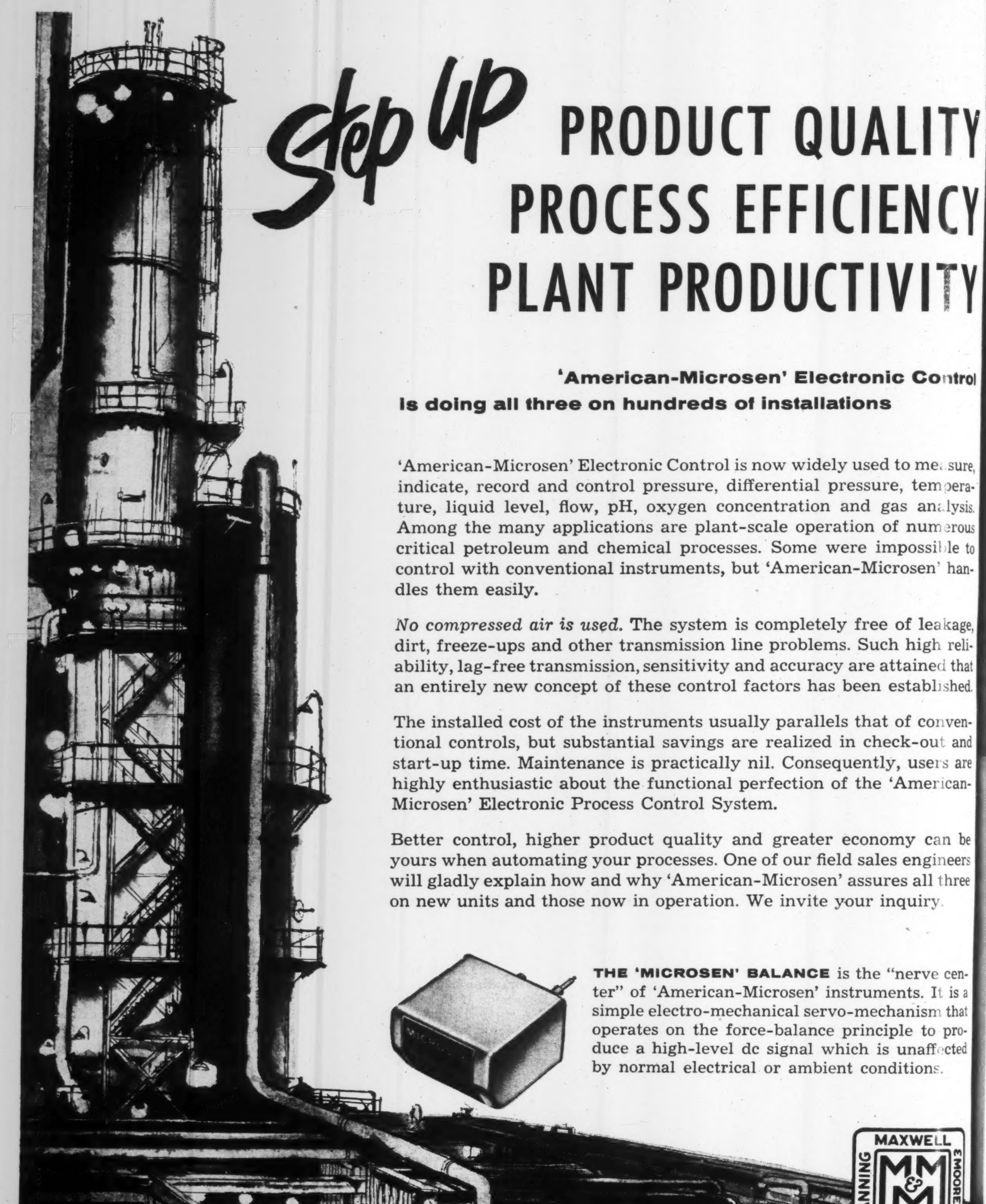
1.3 This procedure is intended to:
  1.3.1 Locate the faulty line in a group of transmission lines.
  1.3.2 Determine if there is a leak.
  1.3.3 Determine if the degree of leakage is allowable.
  1.3.4 Locate the leak.

2.1 On an operating unit:
  2.1.1 Shut off the air supply to the instrument whose transmission line is to be tested.
  2.1.3 Crack the connection on what is believed to be the opposite end of the line. If no pressure is found then it is safe to assume that it is either the line under question or one not likely to be in service.

2.2 On a non-operating unit.
  2.2.1 Disconnect air transmission line at the instrument to prevent damage to bellows or diaphragms.
  2.2.2 Provide clean, dry air at one end of the line. The air pressure should be made to oscillate between 0 to 17 psig.
  2.2.3 Install a small 0 to 30 psig gage in what is believed to be the opposite end of the line and observe for oscillation. The small gage should respond to the oscillation at the opposite end of the line.

2.3 To determine if a leak exists:
  2.3.1 Disconnect the tubing at the controller or receiver and connect the test rig shown in Figure RP 7.1.1.
  2.3.2 Disconnect the plug the other end of the transmission line.
  2.3.3 connect input side of valve "A" to an air supply of clean, dry air at 17 psig.
  2.3.4 Close valve "A" and "B"; open valve "C" on test rig.
  2.3.5 Watch gage on test rig. A drop in pressure indicates leaks.

2.4 To determine if the degree of leakage is allowable:
  2.4.1 With 17 psig blocked in the line, the line may be considered as satisfactory if the drop in pressure does not exceed 1 psi during the test period. The test period is 2 minutes for each 100 feet of ¼ inch line.



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'American-Microsen' Electronic Control is now widely used to measure, indicate, record and control pressure, differential pressure, temperature, liquid level, flow, pH, oxygen concentration and gas analysis. Among the many applications are plant-scale operation of numerous critical petroleum and chemical processes. Some were impossible to control with conventional instruments, but 'American-Microsen' handles them easily.

No compressed air is used. The system is completely free of leakage, dirt, freeze-ups and other transmission line problems. Such high reliability, lag-free transmission, sensitivity and accuracy are attained that an entirely new concept of these control factors has been established.

The installed cost of the instruments usually parallels that of conventional controls, but substantial savings are realized in check-out and start-up time. Maintenance is practically nil. Consequently, users are highly enthusiastic about the functional perfection of the 'American-Microsen' Electronic Process Control System.

Better control, higher product quality and greater economy can be yours when automating your processes. One of our field sales engineers will gladly explain how and why 'American-Microsen' assures all three on new units and those now in operation. We invite your inquiry.

THE 'MICROSEN' BALANCE is the "nerve center" of 'American-Microsen' instruments. It is a simple electro-mechanical servo-mechanism that operates on the force-balance principle to produce a high-level dc signal which is unaffected by normal electrical or ambient conditions.

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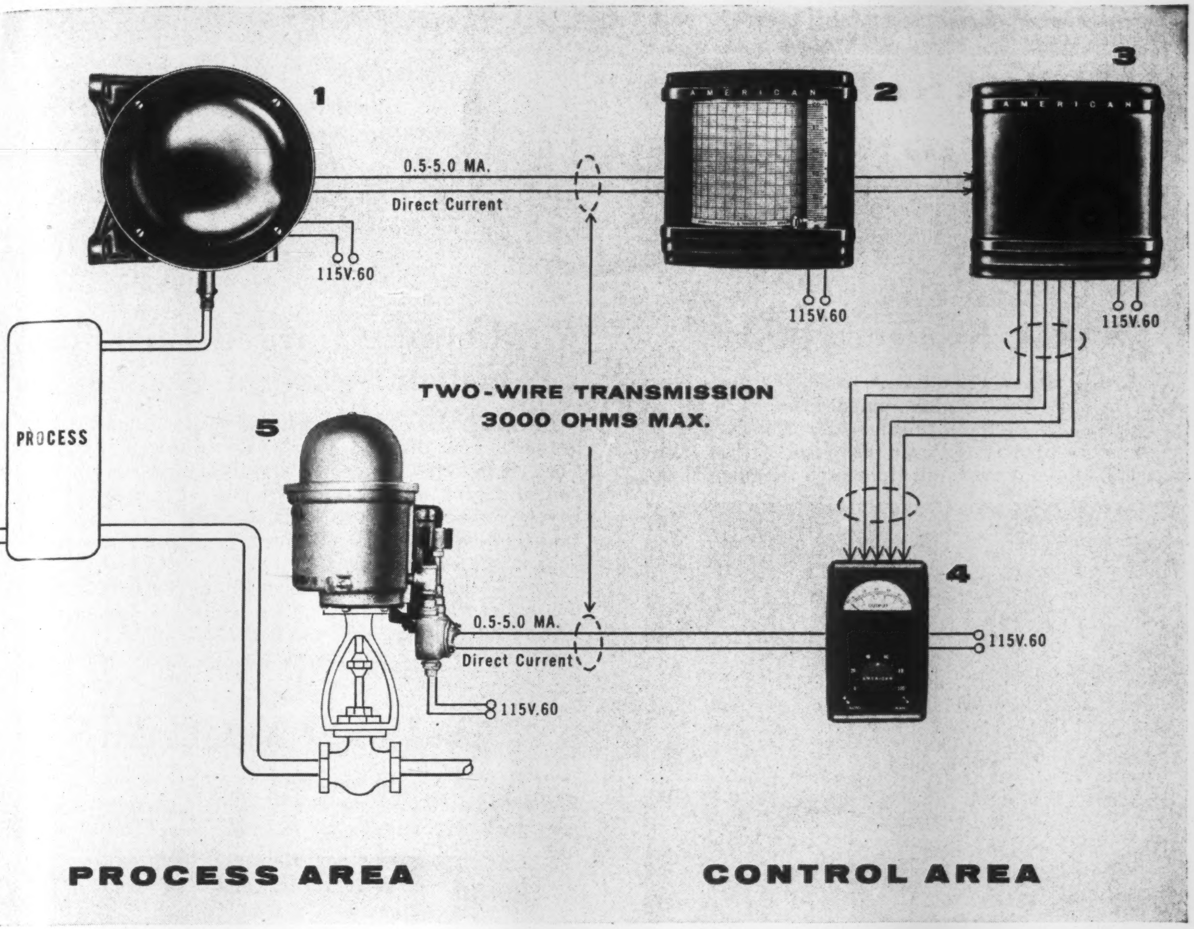

1. TRANSMITTER

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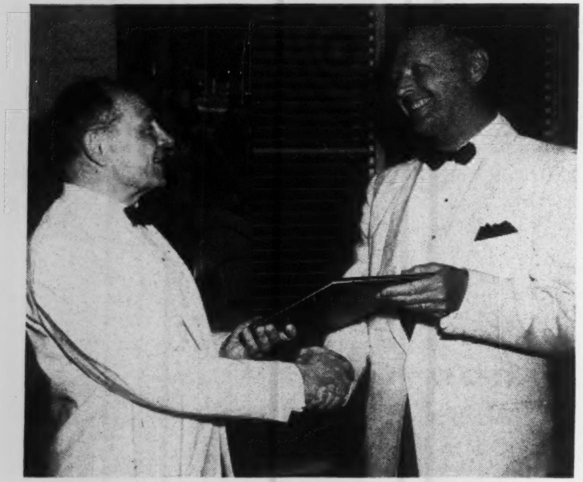
INSTRUMENTS and AUTOMATION News

Principles & Applications ....834 to 850
Stock Report 850
New Plants & Mergers ....855 to 858
People in the News ....863 to 866

SAMA Re-elects Dever

CHICAGO, ILL.—Scientific Apparatus Makers Association held its thirty-eighth annual meeting in Belleair, Florida and re-elected most of the 1955-56 officers and directors. Henry F. Dever, president of Brown Instruments Div., Minneapolis-Honeywell Regulator Co., continues in his office as president of SAMA. The only new names are L. W. Higgins (The Gaertner Scientific Corp.) as chairman of the optical section; R. E. Olson (Taylor Instrument Cos.) as chairman of the recorder-controller section; and G. A. Downsbrough (Boonton Radio Corp.) as a director. No other changes were made.



Harold B. Richmond, board chairman, General Radio Co., received the coveted SAMA Award, the first person in the history of the industry to receive such recognition prior to retirement. Picture shows Mr. Richmond (left) receiving the award from Mr. Dever (right).

A.N.I.P.L.A.

MILANO, ITALY—A.N.I.P.L.A. stands for Italian National Association for Automation, which was founded February 20, 1956, to take its place beside the Belgian Institute of Regulation and Automation, and the Norwegian Committee for Automation. The new association will maintain close ties with these societies, others in the formative stage in European countries, and American groups "for a fruitful international cooperation." It will "promote in Italy the knowledge, study and application of automation from all its various aspects—technical, economic and social."

A Provisional Council includes Dr. Carlo Rossi as president, and Dr. Romeo Mariani and Prof. Cino Poli as vice-presidents.

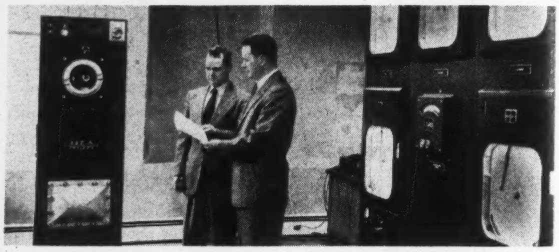
Washburn Awarded Chemical Instrumentation Award

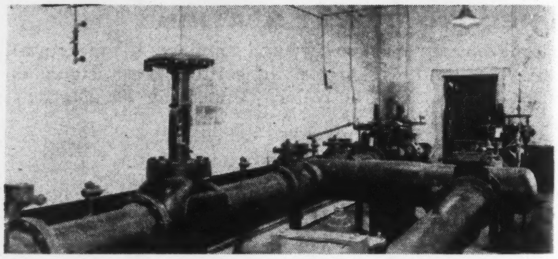
DALLAS, TEXAS—Dr. Harold W. Washburn, Vice president and Director of Consoliated Electrodynamics Corp. is the 1956 recipient of the Beckman Award. This annual award of $1000 is given to a resident of the United States or Canada who has made an outstanding contribution in the development or application of an analytical instrument.

Dr. Washburn is credited with the development of the mass spectrometer from its inception as a laboratory instrument to study properties of matter into a tool of great usefulness in the petroleum, chemical, and medical fields.

Automatic Watchman

PHILA., PA.—An automatic regulator station of the Philadelphia Gas Works has a silent watchman to warn personnel, five miles away, should a gas leak develop.



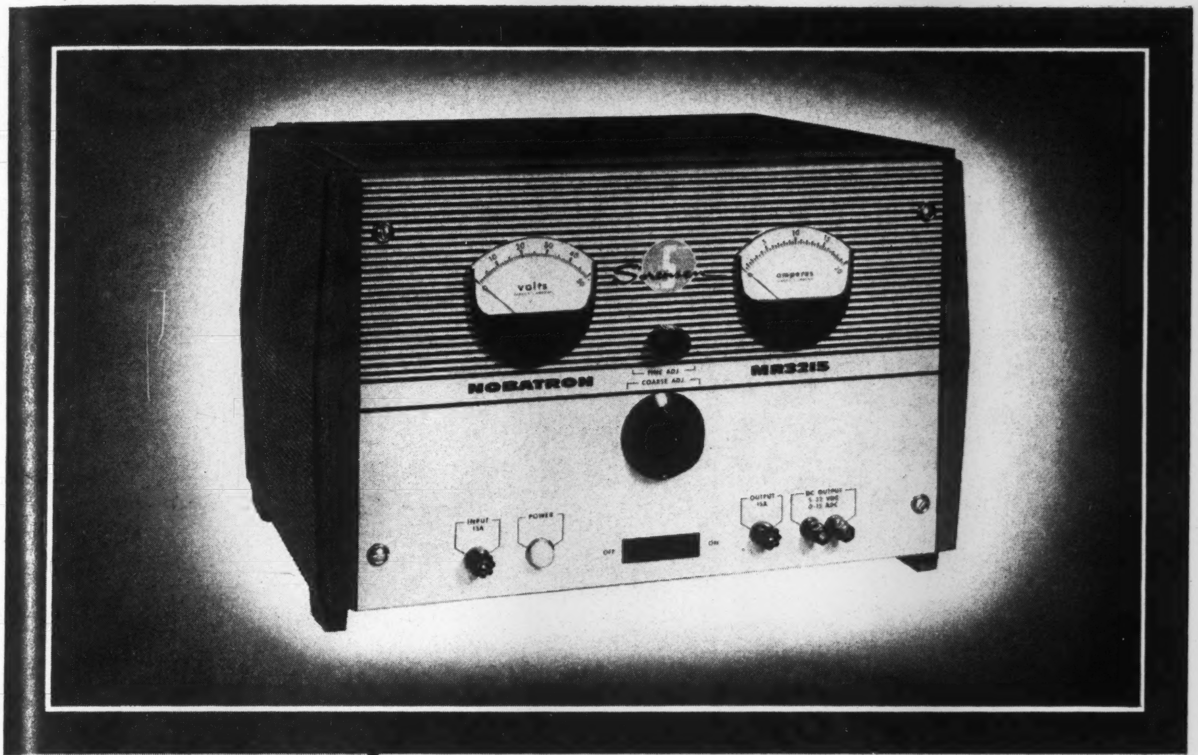


Gas pressure for more than 14,000 customers in the area is controlled from an unmanned station housed in a concrete structure. A PGW employee visits the building only once a week to replace the charts. A Mine Safety Combustible Gas Alarm continuously samples the atmosphere in each of the building's three sections.

Tape Recorded TV

REDWOOD CITY, CALIF.—Magnetic tape recording and reproduction of TV programs has been demonstrated

(*Continued on page* 838)



MA6501

MA6501 — tubeless 0.01% regulated DC supply; 6 and 2 volt outputs.

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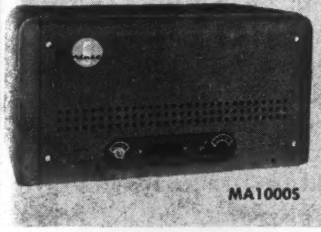
MA1000S — tubeless, dependable 1000VA regulator, ideal for unattended installations.



MA1000S

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new, tubeless, magnetic amplifier

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SORENSEN & COMPANY, 375 FAIRFIELD AVENUE, STAMFORD, CONN.

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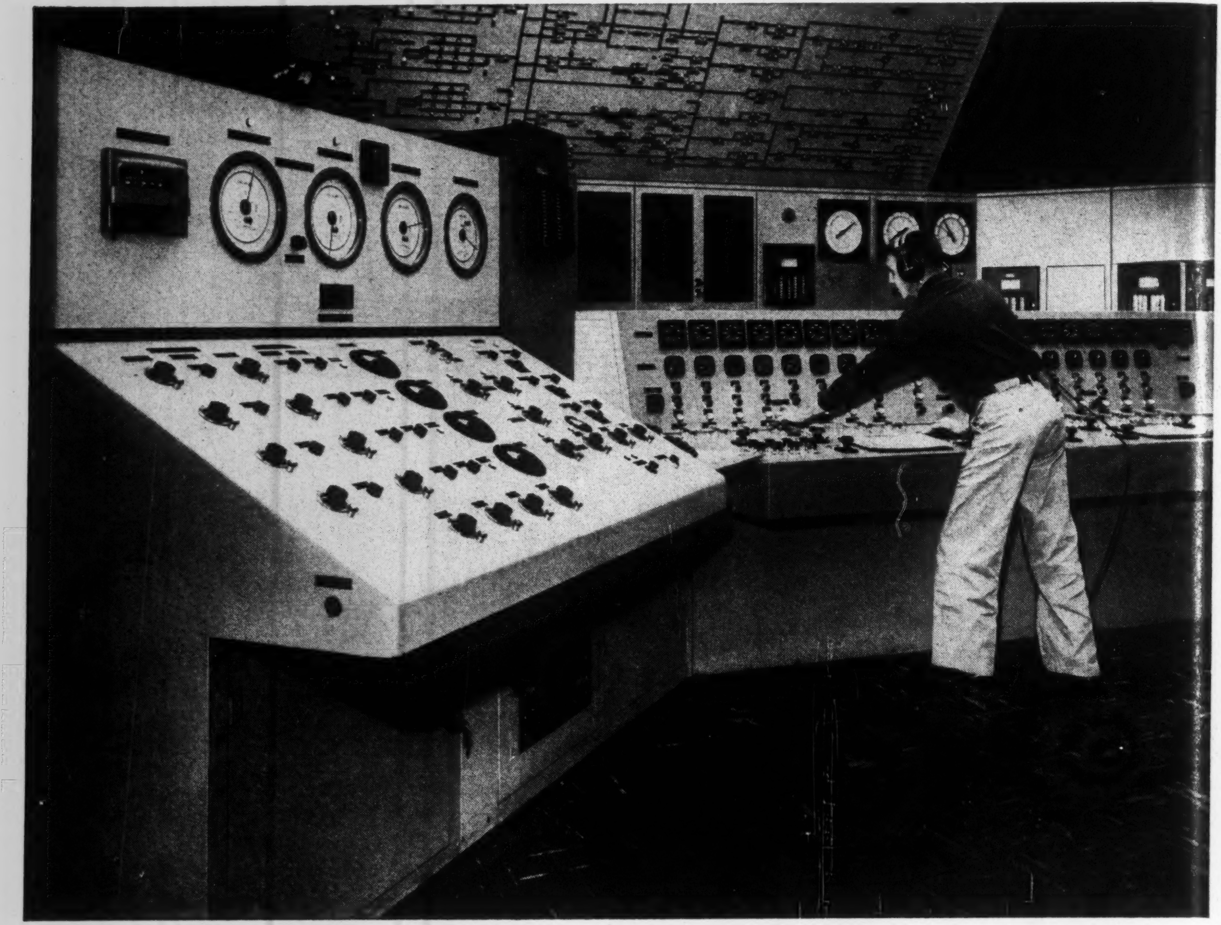


Hagan tames the whirlwind

Hagan automatic altitude control tames a veritable whirlwind at the Arnold Engineering Development Center's Engine Test Facility. The giant Tullahoma, Tennessee testing center, one of the key installations of the U. S. Air Force's Research and Development Command, uses Hagan systems to accurately simulate flight conditions up to 80,000 feet within engine test cells.

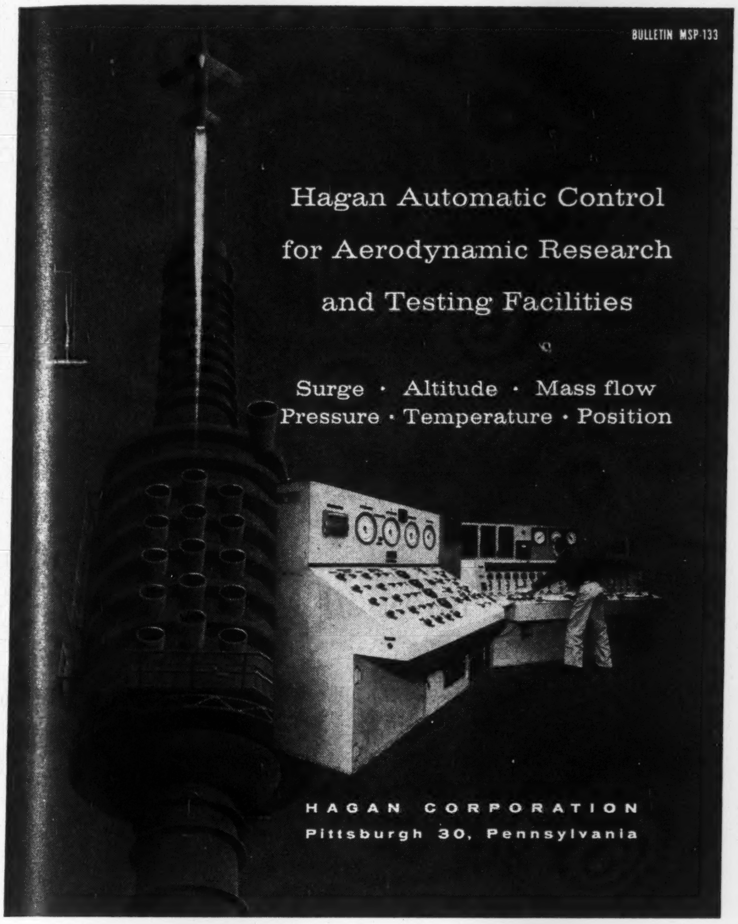
The altitude control is only one of seven major types of Hagan automatic systems, many of which will be used on all three of the A.E.D.C. facilities. The Hagan high performance devices used in these systems are available as separate components or may be integrated into automatic controls for such services as:

Surge Control • Altitude Control • Density Control • Pressure Control • Electro-Hydraulic Valve Positioning • Electro-Pneumatic Valve Positioning • Safety Interlock Systems

Hagan Corporation has been producing control systems for aerodynamic test facilities since 1939. Hagan control and instrumentation systems and components are in service at many of the major test facilities in this country. The development of high speed, high precision devices and electro-hydraulic pilot valves capable of controlling up to 300 fluid hp. have been pioneered by Hagan.

Hagan is prepared to furnish control system components for aerodynamic testing facilities or other process control functions.

For more information circle **21** on inquiry card.



BULLETIN MSP-133

Hagan Automatic Control
for Aerodynamic Research
and Testing Facilities

Surge · Altitude · Mass flow
Pressure · Temperature · Position

HAGAN CORPORATION
Pittsburgh 30, Pennsylvania

NOW AVAILABLE!

NEW CATALOG LISTS HAGAN HIGH SPEED, HIGH POWER COMPONENTS FOR AERODYNAMIC TEST FACILITIES

These Hagan devices provide the research engineer with new tools to facilitate test procedures. Hagan PowrAmp components are extremely accurate and dependable, and include transducers, controllers, computers, amplifiers and high capacity pilot valves. These components are suitable for the instrumentation and control of such factors as:

Surge • Altitude • Mass Flow

Pressure • Temperature • Position

at A.E.D.C.

Bulletin describes General Characteristics of Hagan PowrAmp Components

Hagan Bulletin MSP-133 contains specifications, applications, accuracy classifications, frequencies, and inputs and outputs of twenty-two different units. The units described include transducers, amplifiers, converters, controllers and a variety of other devices such as signal shapers, signal generators, power supplies, control stations and others.

Copies of this catalog available on request—ask for Bulletin MSP-133.

HAGAN CORPORATION
HAGAN BUILDING, PITTSBURGH 30, PA.

Systems and Components for: Aeronautical Testing Facilities, Process Control, Boiler Combustion Control, Metallurgical Furnace Control • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.

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successfully by Ampex Corp. CBS has ordered the first three prototype units at $75,000 each and expects improvements of the quality of its programs from this new equipment. Its intended primary use is in overcoming the three-hour East-West time differential.

Instrumentation in India

WASHINGTON, D. C.—Statistics released by the U.S. Dept. of Commerce (Business Service Bulletin 137) on India as a market for instruments show an estimated $38 million annual consumption of all types, of which 60% are imported. The United Kingdom, with empire preferential duties, gets the lion's share while the United States is third on the list. Switzerland takes the second place due to its horological instrument exports to India, which amounted to $9 million out of $11 million for 1952 through 1954 in the nearly $17 million category of scientific and laboratory instruments. In this category U.S. exports totaled up only to $1.3 million.

In the group of industrial and process instruments exported by the four major contributing countries (including Germany) the picture was brighter, U. S. participating with 1/3 out of over $16½ million total imports, and running a good second behind the United Kingdom.

With a population of 371 million and a steadily rising per-capita income, India constitutes a considerable market. Officials foresee an enormous rise in industrial production with their second five-year plan, providing more potential customers than almost any other country.

U.S. contributions were principally in automatic controls (50% of total U.S. exports). With India's lack of specialty steels and specialized technical personnel, the prospects are excellent for greater imports from the U.S. if the dollar-exchange situation is eased.

Of scientific and laboratory instruments, India's domestic production covers most of the demand for equipment used in schools and scientific laboratories, as well as in the optical field (with the exception of complicated instruments where U.S. participation is high and is expected to continue on the same level). Flight, navigational, meteorological and geological instruments, as well as nuclear radiation detection devices offer a good field, and shipments from the U.S. (which in 1954 doubled the combined 1952/1953 figures to over $300,000) are expected to grow at the same rate.

Evan E. Kimble

Col. E. Kimble, founder of Kimble Glass Co., Vineland, N. J., and a longtime leader in the laboratory glass industry, died March 15, at the age of 86. His death was called the "end of an era" in the nation's laboratory supply field by Kenneth Andersen, executive vice president of SAMA.

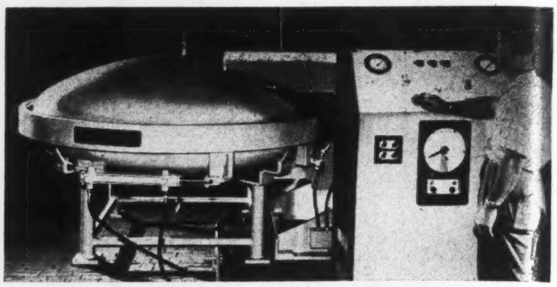
Col. Kimble was chairman of the SAMA board 1942 to 1944 and received the SAMA award in 1951.

Guido Ferrara

Ferrara, Inc., Oak Park, Mich., has lost its president in the untimely death of Guido Ferrara at 41. He was a former associate professor and director of the electrical engineering department of the University of Detroit. He is survived by his wife, two sons, and parents.

Automatic Autoclave

PHILA., PA.—A new autoclave produced by Philips & Davies of Kenton, Ohio, is designed for batch processing at pressures to 100 psig and temperatures to 500°F. A control cubicle, designed by Leeds & Northup Co., monitors a complete program of heating, controlled "hold" at the desired temperature, and cooling.



This is done through the on-off operation of solenoid operated steam valves.

Baseball Predictions

PASADENA, CALIF. — Dr. Martin Klein, well known to readers of *I & A* as co-author of the "Digital Automation" series, has extended the use of Electro-Data Corp.'s "Datatron" computer to predict the 1956 pennant winners in the two major baseball leagues. His predictions received national prominence via syndicated news services.

According to the findings we can look forward to a world series between Detroit and Brooklyn.

Data fed into the computer consisted of thousands of statistics from the past 3 seasons, including day-by-day scores, hits, runs, home runs, errors and batting percentages. All the players have to do now is to live up to the circumstances created by them in the three-year period.

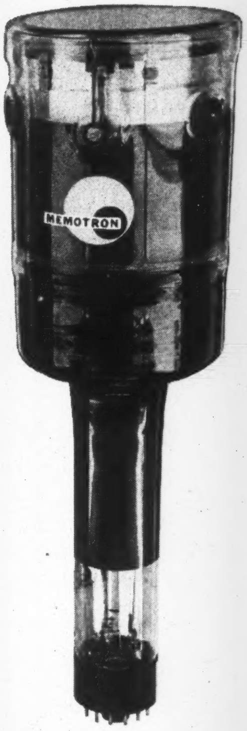
Measurement of 400,000° F

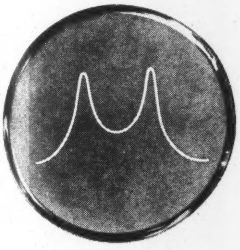
BALTIMORE, MD.—For the first time under laboratory conditions, man has produced temperatures of well over 400,000°F and corresponding brightness 700 times greater than at the surface of the sun.

Scientists of the Air Research and Development Command at the Air Force Cambridge Research Center have measured these temperatures, which have a duration less than a microsecond. The extremely high temperatures involve the release of electric energy into a very small volume of inert gas under high pressure. A specially designed capacitor circuit is employed to store the energy and release the electric discharge. The capacitor circuit, applied to the basic gaseous discharge technique, is pri-

HUGHES MEMOTRON

A NEW TYPE OF CATHODE RAY TUBE

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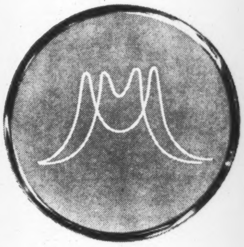
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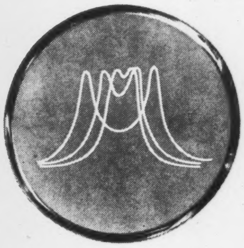
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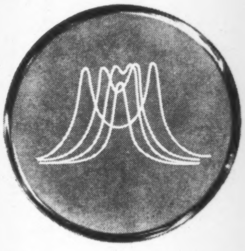
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MAINTAINS brilliant traces indefinitely.

Now you can examine nonrecurrent phenomena without resorting to photography. The Memotron, a direct display cathode ray storage tube, retains transients—permits leisurely examination on the tube face itself.

There is no blooming or fading. And the high tube brilliance permits its use without a hood, even in well-lighted surroundings.

DISPLAYS successive transient writings.

Even the most complex patterns can be superimposed or shifted in position. The Memotron tube thereby enables you to make convenient comparisons and analyses.

INSURES superior file records.

When a file record is needed, photography is greatly simplified because all displays occur at a constant, uniform brightness regardless of differences in writing speeds. Therefore, a single camera exposure setting is sufficient.

FUNCTIONS as curve plotter.

An oscillograph equipped with a Memotron combines, into one instrument, pen-recorder performance at low frequencies and oscillograph performance at high frequencies. Successive writings may be stored to produce a family of curves.

TYPICAL APPLICATIONS: As a read-out device for the display of solutions produced by an analog computer . . . for recording shock transients during shock testing . . . in medicine for electro-cardiography and vector-cardiography. Illustrated: a technique for plotting a family of curves, representing a coupled circuit with varied parameters.

GENERAL SPECIFICATIONS

RESOLUTION . . . 50 to 60 written lines per inch.
WRITING SPEED . . . 0 to at least 100,000 inches/second (selected tubes in excess of 100,000 ips).
BRIGHTNESS . . . 50 foot-lamberts.
USABLE SCREEN DIAMETER . . . 4 inches, maximum.
DIMENSIONS . . .
Over-all length: 18 1/2 inches, ± 1/2-inch.
Bulb diameter: 5 5/8 inches, maximum.
Neck diameter: 2 1/4 inches, ± 3/32-inch.

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

For descriptive literature, please write:

HUGHES PRODUCTS
ELECTRON TUBES
11220 South Hindry Street
Los Angeles 45, California

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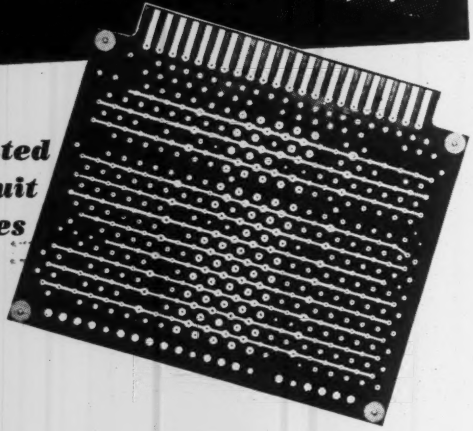
For more information circle **22** on inquiry card.

TRACER-GUIDED DRILLING

100 HOLES P. M.

WITH NEW HERMES Engravograph

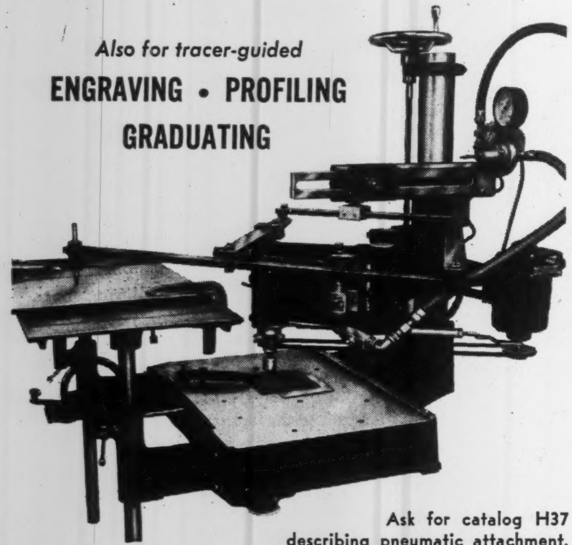


for printed circuit plates

- Pantograph reproduces drill pattern from template in any reduction ratio — assuring high accuracy.
- Allows drilling and routing of different size holes in one operation without changing tools.
- Pneumatic attachment with adjustable feed gives high speed production.

Also for tracer-guided

ENGRAVING • PROFILING
GRADUATING



Ask for catalog H37
describing pneumatic attachment.

new hermes
ENGRAVING MACHINE CORP.
13-19 University Place, New York 3, N.Y.

marily responsible for the resultant high temperatures.

The experiments and the resulting measuring device were conducted by Dr. Heinz Fischer, Chief of the Electro-Optical Section at the Cambridge Research Center.

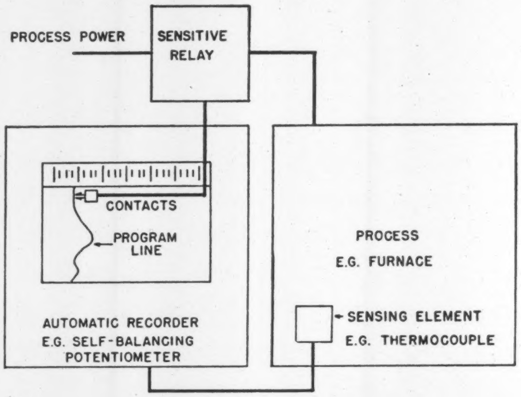
Guided Missile Range

NEW YORK, N. Y.—Participation of Reeves Instrument Corp. in the instrumentation of the U.S. Air-Force Air Research and Development Command's Florida Guided Missile Range was disclosed.

Twenty-one automatic radar installations can track the flight of long-range guided missiles from the launching site near Cocoa Beach, Florida, over its full range, within two one-hundreds of a degree, record its course, velocity, and accelerations, and report back to the Flight Control Test Center.

Program Control

WASHINGTON, D. C.—F. A. Brandt and Floyd Brown of the Naval Research Laboratory, Washington, D. C., have shown in article recently published in the NBS *Technical News Bulletin* how to convert an Automatic Recorder into a flexible Program Controller. The simple system consists of a line drawn in pencil on the recorder chart (representing the desired program) and a device which is attached to the recorder pen carriage. The latter detects the presence or absence of the line, returns the carriage to it and thus controls the process. The conductance of the lead pencil line (or better an IBM electrographic sensing pencil) is sufficient to energize a thyratron control circuit from two contacts attached to the pen carriage. The system can be used on circular or strip charts, X-Y recorders, etc.



Cement Analysis

WASHINGTON, D.C.—The National Bureau of Standards has developed methods for flame-photometric determination of two more minor constituents of cement. Strontium and manganese have been added to the list of titania, sodium and potassium which rapidly can be determined quantitatively. A standard spectrophotometer with a flame photometer attachment, an oxy-hydrogen burner, and a photomultiplier attachment are the instruments used. It has been found that strontium contents

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NOW! A BRAND-NEW CONCEPT IN FLOW TOTALIZING!

...THE NEW FOXBORO FLYBALL INTEGRATOR

Inherently Accurate!

- Eliminates Inaccurate "Spot Check" Counting!
  Continuous integration assures highest precision.
- Eliminates Cam and Linkage Errors!
  Unique design balances differential pressure signal directly against centrifugal force.
- Eliminates Calculations!
  Automatically extracts square root — shows totals in desired units.
- Eliminates Fire and Explosion Hazards!
  Simple, all-pneumatic operation requires no electric motors, wires, or contacts.

FOXBORO
REG. U. S. PAT. OFF.

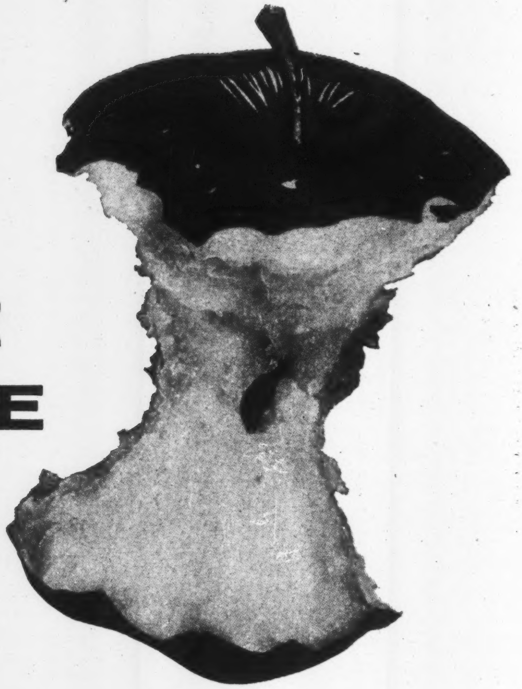
Now you can integrate the flow of all process fluids or plant services *continuously* . . . with new accuracy . . . complete safety! The unique new, all-pneumatic Foxboro Flyball Integrator completely eliminates intermittent counting and fire hazard. Its simple, force-balance operation utilizes the 3-15 psi air signal from any differential-pressure flow transmitter. This signal is *continuously* balanced against the "flyball" force of the instrument's pneumatically-driven turbine. The square root function is automatically extracted . . . you read flow totals *directly*.

The Flyball Integrator mounts at the point of measurement or on a panel hundreds of feet away. Response and accuracy are completely unaffected by ambient temperature changes or pressure changes in turbine air supply. Ideal solution to all plant fluids accounting and in-process inventory checking. Write for complete details. The Foxboro Company, 465 Neponset Ave., Foxboro, Mass.

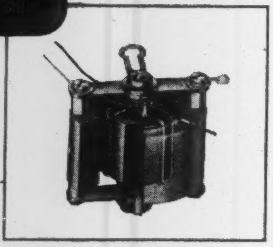
FIRST IN FLOW

For more information circle **23** on inquiry card.

QUALITY RIGHT TO THE CORE



MILLIAMPERES
D.C.
WESTON
VOLTS
D.C.
WESTON
MODEL 1301
1000 Ω/VOLT



Weston CORMAG® mechanism shown in phanton cutaway—a compact, light-weight permanent magnet moving-coil mechanism; self shielded from the effects of external magnetic fields.

Everything about the Model 1301 line of Weston panel instruments is different . . . from the terminals and lance type pointer right through to the core-magnet mechanism . . . not forgetting the lower price. The big attraction, of course, is the highly perfected Weston CORMAG® mechanism which provides excellent shielding from external fields, thus permitting their use interchangeably on magnetic or non-magnetic panels without need for adjustment, and eliminating any intereffect of instruments on one another when mounted in close proximity. For the complete story on the 1301 line, and on other WESTON instruments for panel use including the famous *ruggedized* line, consult your nearest WESTON representative, or write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J. A subsidiary of Daystrom, Incorporated.

WESTON
CORMAG®
PANEL INSTRUMENTS

For more information circle **24** on inquiry card.

(in form of its oxide) ranges from 0.02 to 0.39% (the average being 0.14%) depending on place of origin. Manganese oxyde contents ranges from 0.013% in white Portland cement to 0.60% in Portland blast-furnace-slag cement. Results obtained by this new, rapid method check closely with percentages obtained by the colorimetric method.

News Bits

SOLAR ENERGY was the topic of world symposium held at Phoenix last November. Registrations numbered 800. Proceedings (30 papers given by scientists from Australia, England, France, Israel, Japan, South Africa and the U.S.S.R.) are now available for $5.00 from the Association for Applied Solar Energy, 204 Heard Building. Phoenix, Ariz.

PORTABLE WATER VAPOR ANALYZER which will measure concentrations of less than one ppm in flowing samples has been developed by DuPont's Eng. Res. Lab. Dr. Frederick A. Keidel disclosed the new instrument at the recent Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy.

EUROPEAN INSTRUMENT SHOWS are sprouting this spring. Scheduled for April were: Wiesbaden, Germany; Oslo, Norway; Paris, France; and Milan, Italy. In May Sweden follows with the International Atomic Power Exhibit in Gotenburg, and the Netherlands with the Sixth Spectro Colloquium in Amsterdam. Participation by American firms in all has been reported.

COLUMBIA UNIVERSITY made a study for Atomic ndustrial Forum, Inc. (a non-profit association) on isaster possibilities if nuclear reactors were to get out f control.

BATTELLE MEMORIAL INSTITUTE reports development of a cascade impactor, a device for measuring ze distribution of particles dispersed in air—also estabshment of an Electronic Reliability Division.

O-RINGS

are a valve's best friend

Let's face it . . . dripping, leaky valves are just not socially acceptable . . . so, we designed the new Hoke bar stock needle valve with an O-ring stem seal—to give it the right start in life. Result—a seal that will pass a helium leak test and no leaky, messy packing adjustments—ever. No friction either (even at high pressure)—you can operate the valve with a fingertip touch. There's a new, self-aligning spindle which shuts off tight time after time without galling or binding.

As you can see, the Hoke bar stock valve will contribute ease of operation, low maintenance cost and neat appearance to your equipment—hydraulic, pneumatic, instrument panel or test stand. It's available from stock in a wide range of sizes (1/8" to 1/2" pipe) and materials (carbon, chrome or stainless steel and brass) . . . panel mounting, too if you need it. We'd like to send you our Bulletin.

P.S. We've just published a new wall chart on Hoke valves with valuable information on valve sizing and corrosion resistance. May we send you one?

HOKE

HOKE INCORPORATED
Fluid Control Specialists
231 S. DEAN STREET, ENGLEWOOD, N. J.

For more information circle **25** on inquiry card.

We asked Servo Engineers what they needed

new

SERVO ANALYZER

For testing
Servo Systems in:

missile guidance systems
aircraft control systems
machine tool control
material handling systems
automation systems
autopilots

LECTRONICS COMPANY

This new amplifier, coupled to a Brush direct-writing oscillograph, provides a package unit to record performance of any servo system operating in the carrier frequency range of 50 to 10,000 cps. It offers performance features available for the first time—features requested by leading Servo Engineers in a survey made by Brush application specialists.

EXCLUSIVE FEATURES

Exceptional frequency response . . . on a 400-cycle carrier, 1 db down at 100 cycles. On a 60-cycle carrier, 1 db down at 4 cycles, 3 db down at 7 cycles.

Flexibility . . . a high impedance input permits use in either single-ended or balanced operation. Error signal is isolated from the reference signal. In addition, pen drive d.c. amplifier section can be used as a separate unit.

High accuracy . . . phase-shift compensated attenuator permits holding phase shift to negligible amounts. Phase shifter with calibrated dial permits determining phase shift between error and reference signals within 1 degree.

The Brush Servo Analyzer system permits complete servo operation testing and trouble-shooting. Immediately available records aid in: synchronizing signals, measuring feedback signals, carrier phase measurements, checking angular difference, measuring voltage magnitude and wave shape, etc. Ask your Brush representative for complete information on the Model BL-560, or write Brush Electronics Company, Dept. A-5, 3405 Perkins Avenue, Cleveland 14, Ohio.

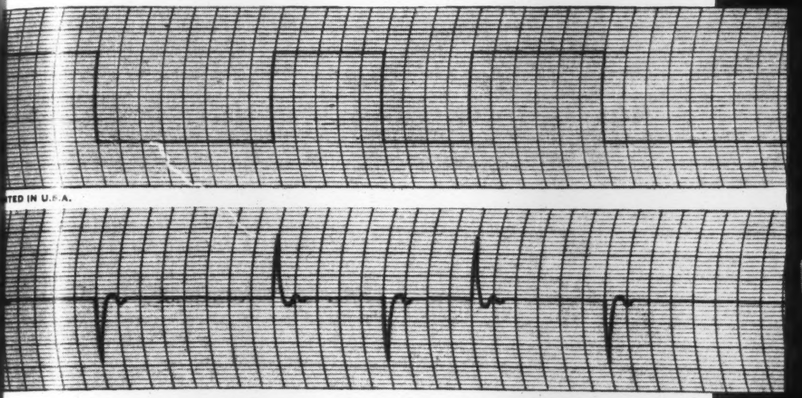
BRUSH ELECTRONICS BRUSH ELECTRONICS **COMPANY**
3405 Perkins Avenue, Cleveland 14, Ohio
DIVISION OF
CLEVITE CORPORATION

For more information circle **26** on inquiry card.

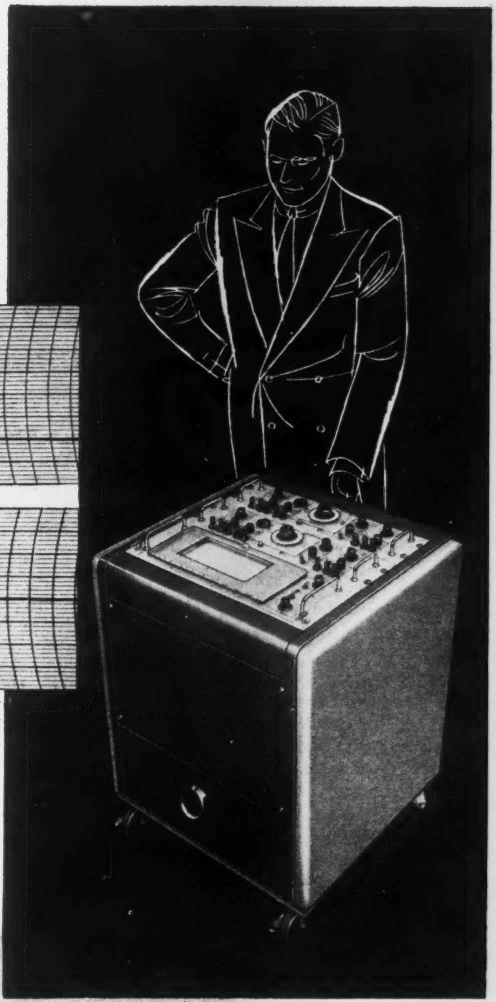
in test instrumentation...then we designed the

Brush

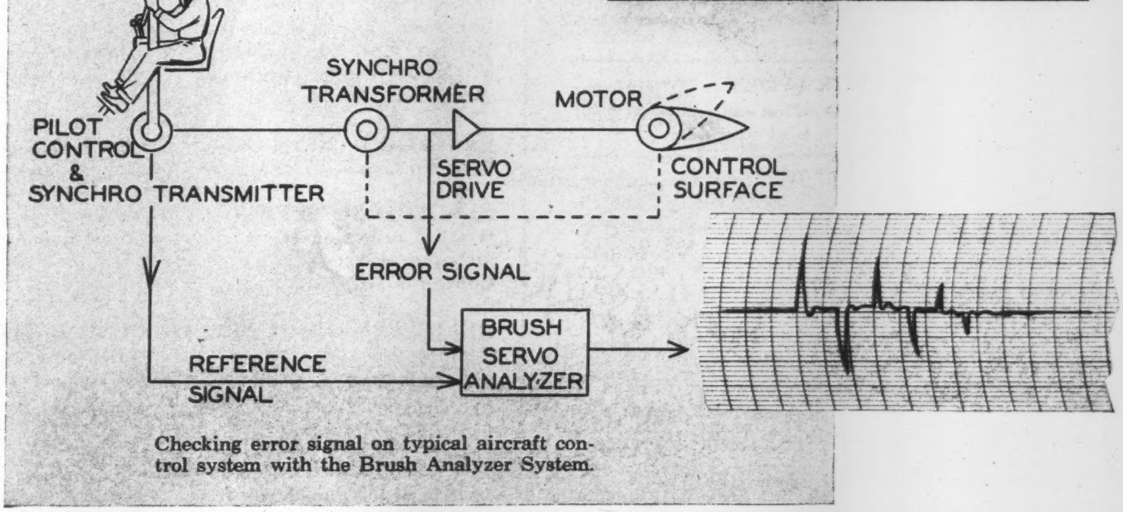
AMPLIFIER



▲ Two channel recording of test of servo control system. Up to six channels of information can be recorded if desired.



Mobile instrument cart carries complete gear ▶ for servo testing, consists of two amplifiers and dual channel oscillograph. Equipment can also be mounted in racks or consoles.


PILOT CONTROL & SYNCHRO TRANSMITTER
SYNCHRO TRANSFORMER
MOTOR
SERVO DRIVE
CONTROL SURFACE
ERROR SIGNAL
REFERENCE SIGNAL
BRUSH SERVO ANALYZER

Checking error signal on typical aircraft control system with the Brush Analyzer System.

For more information circle **26** on inquiry card.

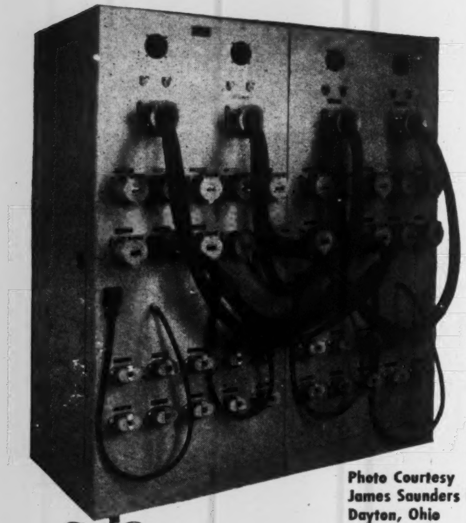


Photo Courtesy
James Saunders Co.
Dayton, Ohio

BETTER
AUTOMATION
REQUIRES BETTER
Electrical Connectors

Downtime is Automation's most relentless enemy. That's the reason every link in a production chain should be carefully selected. Electrical Connectors in power feeder and control circuits, for example, must do more than merely meet electrical specifications. To provide dependable long-lasting service they must also be highly resistant to damage by oils, acids and rough handling . . . and when connected, must not permit moisture or dust to contaminate their contacts. JOY one-piece Neoprene insulated connectors meet all these requirements and they're available in a wide variety of single and multiple-contact designs. Want more facts? Ask and we'll mail them . . . ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** *In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

and
JOY
Connectors are better Electrical Connectors

OIL SEALED — One-piece molded cable/connector assembly protects conductors from oil and other external impurities.

DISTORTION-PROOF — JOY Connectors cannot crack, will not shatter and are practically impossible to knock out of shape.

MOISTURE-TIGHT — Water cannot penetrate one-piece, molded body and face seals protect contacts when connectors are engaged.

CD 156.1

JOY
INDUSTRY
Free . . .
New Bulletin — Ask for No. B59

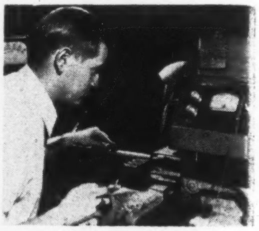
JOY
SOURCE OF INDUSTRY'S FAVORITE ELECTRICAL CONNECTORS SINCE '28

For more information circle **27** on inquiry card.

FIRST INTERNATIONAL ANALOGY COMPUTATION MEETING was held in Belgium in September 1955. Proceedings were published in April (cost: 600 Belgian francs). Formation of an "Association International Pour le Calcul Analogique" was also announced.

KAY-LAB ITV, with 3 monitors installed in control tower at Alameda (Calif.) Naval Air Station, considerably improves visibility of end of runway to protect vehicular traffic on road crossing line of air traffic there. Official photograph of U. S. Navy illustrates this fact.

Kay-Lab ITV.


Brush Surfindicator.

BRUSH ELECTRONICS showed in several installations how moving their Surfindicator from the inspection department into the shop for checking surface finish right at the machine saves manhours.

BENDIX AVIATION is mass-producing a simple dosimeter about the size and shape of a fountain pen able to measure up to 600 roentgens of gamma radiation (from an atomic or hydrogen bomb).

MIT announces several summer courses in the instrument and allied fields ranging from one to two weeks in July and August: (1) Recent Developments in Fluid Power Control, (2) Metallurgical Applications of X-ray Diffraction, (3) Control System Engineering, (4) Infrared Spectroscopy, (5) Electronic Computers and Business Problems, (6) Business Management and Electronic Data Processing, (7) Analog-Digital Conversion Techniques.

BAIRD ASSOCIATES has a new apparatus for use in high-dispersion interferometry which is claimed to be 100 times more accurate than standard meter methods. Mercury^{198} source (prepared by transmutation of gold in an atomic pile) determines wave-lengths with 1-ppm accuracy.

STANFORD RESEARCH INSTITUTE scientists have developed a friction measurement apparatus.

ELECTRONIC SPECIALTY CO., Los Angeles, has received orders in excess of one-half million dollars in airborne electronic equipment for the new supersonic Convair F-102A Interceptor.

PRECISION PHOTOMECHANICAL CORP. announces a new mass production process for manufacturing involutes and spirals with tolerances held to 0.0001 inch.

BALDWIN-LIMA-HAMILTON SR-4 load cells are recently finding such diversified applications as (1) gaging of bins of hot calcinated ore for smelting, (2) weighing of scrap metal in small hopper cars (with indicator and

Circle **28** on inquiry card. →

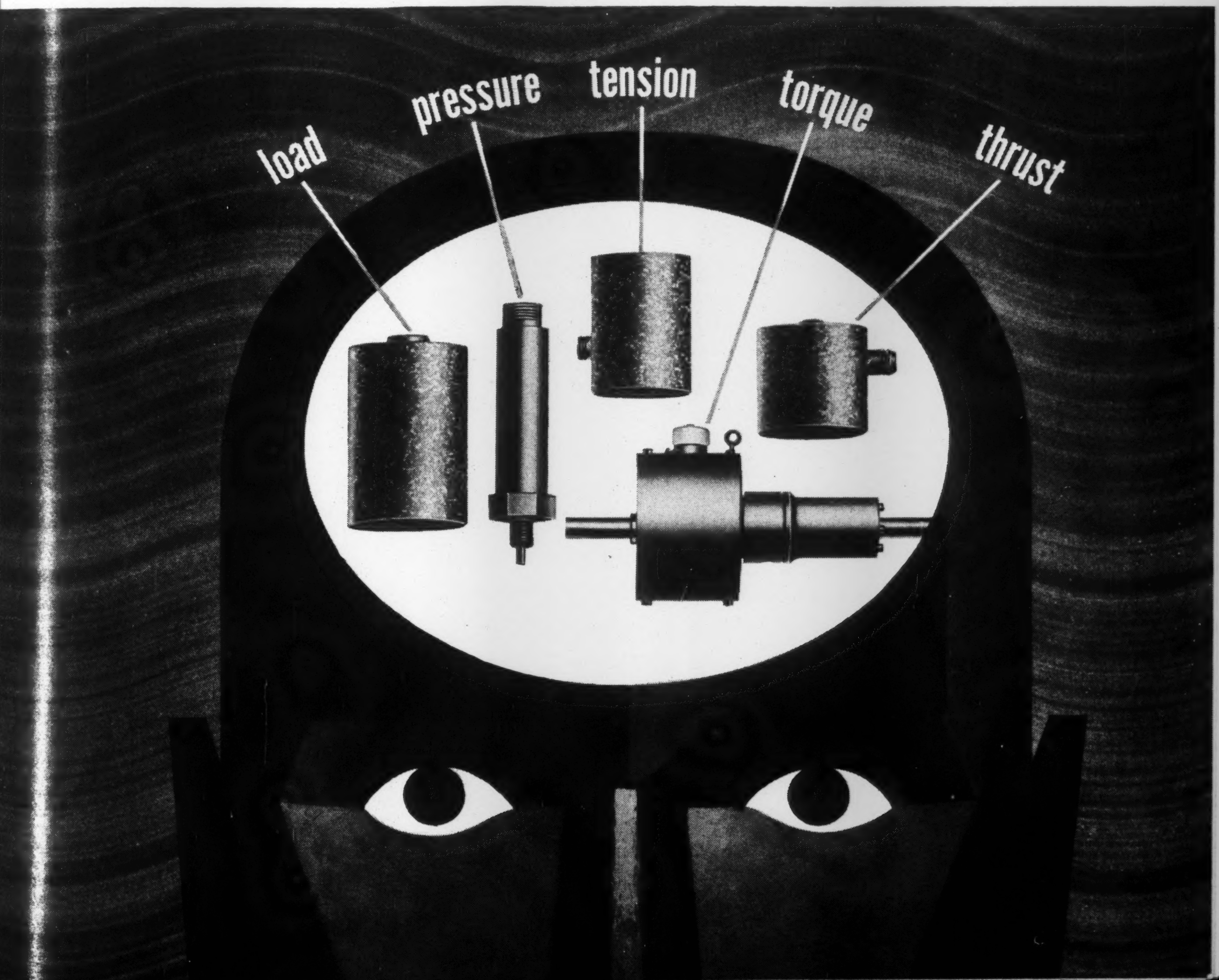
electronic "brains" for industrial control

Do you need to measure and control weight, pressure, tension, torque or thrust? You can do it best with a Baldwin electronic SR-4® system—the system that's instantaneously responsive, highly accurate, always reliable and maintenance-free.

Easy-to-install Baldwin strain gage type transducers are the load-sensing elements. They transmit signals to Baldwin indicators, recorders, controllers, or other appropriate instrumentation . . . i.e., load cell output can also be fed to a digital printer or computer.

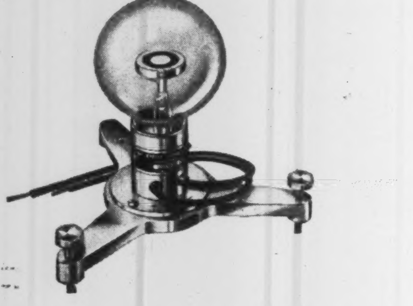
Closed-loop SR-4 systems are engineered to meet your specific requirements. Find out now how these electronic "brains" can solve *your* control problems. For bulletin 4300, write Dept. 2653, Electronics & Instrumentation Division, BLH Corporation, 806 Massachusetts Ave., Cambridge, Mass.

ELECTRONICS & INSTRUMENTATION DIVISION
BALDWIN-LIMA-HAMILTON
DIVISIONS: Austin-Western • Eddystone • Lima • Hamilton • Electronics & Instrumentation • Loewy-Hydropress • Madsen • Pelton • Standard Steel Works



EPLAB

PYRHELIOMETER
For the Measurement of
SOLAR RADIATION



Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

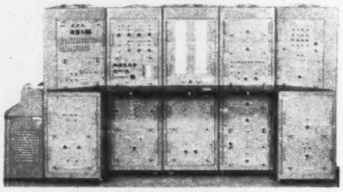
Scientific Instruments

2 Sheffield Ave.
Newport, Rhode Island U. S. A.

For more information circle **29** on inquiry card.

digital printer), (3) stress measurement in bolts for 16,000 psig pressure vessels, (4) control of aircraft tire loads on test stand.

ELECTRONIC ENGINEERING CO. recently completed delivery of a high speed testing device which electronically simulates the conditions of firing a guided missile while it undergoes production tests. The equipment is to be used in the testing of the FALCON missile at Hughes Aircraft Tucson plant.



EECO Electronic Simulator.

Haloid Process.

HALOID CO. has come up with a new process for using xerography for the preparation of printed electrical circuits. Great savings in time and money are claimed.

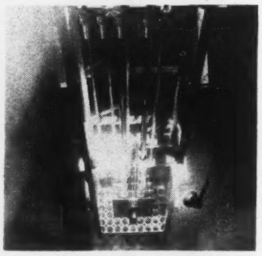
GE has recruited 137 graduate engineers for its Light Military Electronic Equipment Department in Utica, N. Y.

CONSOLIDATED ELECTRODYNAMICS reported all-time high sales for 1955 surpassing the previous record set in 1954 by 9.5%; also a back-log of $4.5 million, the largest in the company's history.

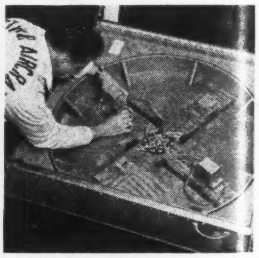
SPERRY-GYROSCOPE DIV.'s new SP-30 fully-transistorized flight system for automatic control of jet airliners is hailed as advance in automatic flight control.

SURFACE COMBUSTION CORP.'s Kathabar (lithium-chloride-base humidity conditioning system) maintains relative humidity of 50% ±1% at 75°F in Ohio boxboard company lab, which is half the tolerance specified by TAPPI.

LEEDS & NORTHRUP instrumentation safeguards Penn State University's research reactor. Close-up view into 20-ft. deep "swimming pool" shows control rods, fuel elements and grid work.



Penn State reactor.



Northrop centrifuge.

MISSILE INSTRUMENTATION at Northrop Aircraft for testing electronic components subjected to high stresses include this 30″-dia. centrifuge where accelerations to 100 Gs are possible.

UNIVERSITY of MICHIGAN, College of Engineering, has the following courses on its summer program for June, July and August: (1) Digital Computers and Data Processors, (2) Ceramic, Ferromagnetic, and Ferroelec-

PRECISION PRESSURE MEASUREMENT
of Gauge Pressure, Vacuum or
Differential Pressure

Precision Dial Manometer Type FA-145

Accuracy:
1 part in 1000 over full scale.
Sensitivity:
1 part in 10,000 in *all* ranges.
Ranges:
0 to 120 inches of water (min.)
0 to 250 inches of mercury (max.)
Other intermediate ranges available.
Scale Length:
45 inches.
Dial Diameter:
8½ inches.

MERCURY
120 INCHES
MODEL NO.
SERIAL NO.
WALLACE & TIERNAN PRODUCTS INC.
BELLEVILLE NEW JERSEY

DIFFERENTIAL PRESSURE
1
2
3
4
5
6
7
8
9
10
INCHES OF WATER

Precision Low Pressure Gauge Type FA-141

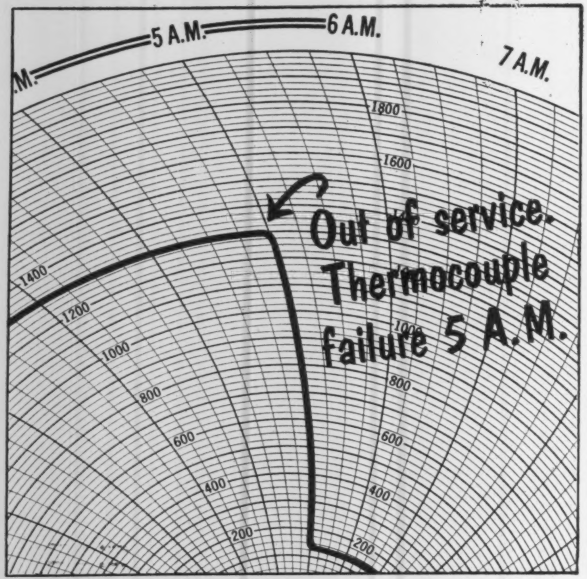
Accuracy:
1 part in 300 over full scale.
Sensitivity:
1 part in 500 in *all* ranges.
Ranges:
0 to 10 inches of water (min.)
0 to 400 inches of water (max.)
Other intermediate ranges available.
Scale Length:
7 or 16 inches.
Dial Diameter:
2¾ or 6 inches.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST., BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

For additional data, write for Publication TP-30-A and TP-27-A

A-101

For more information circle **30** on inquiry card.



YOU CAN CUT INSTRUMENT DOWN-TIME for service from hours to minutes in most cases with an adequate supply of Bristol thermocouples and pyrometer accessories.

How much can interrupted pyrometer service cost you?

Now's the time to worry—before it happens—about what interrupted pyrometer service can do to your production schedules, cost figures, and quality controls.

And now's the time to lay in a supply of Bristol's pyrometer supplies and accessories to cut down-time to a minimum. Bristol's complete line of thermocouples, protection tubes, radiation-unit accessories, refractory insulators, mounting fixtures, thermocouple wire, and extension wire, switches, ink, and charts, are available in a wide selection of interchangeable sizes and types to fit all standard installations.

They're backed by Bristol's 51 years experience in industrial pyrometry. We've built thousands of pyrometers for every application—in iron, steel, non-ferrous metal smelting and refining; in petroleum, chemical, ceramics, glass, paper, and food-processing industries and in power, heat and incineration utilities.

You'll find these pyrometer supplies completely described in our 56-page Bulletin P1238, together with technical data on selection, installation, maintenance, and calibration. Write for your copy today. The Bristol Company, 154 Bristol Rd., Waterbury 20, Conn.

THERMOCOUPLES AND PYROMETER ACCESSORIES
Buyers' Guide and Users' Manual
Bristol

FREE BULLETIN P1238. Tells how to select, install, calibrate and care for thermocouples and pyrometer accessories.

6.18

BRISTOL *Points the Way in Human-Engineered Instrumentation*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **31** on inquiry card.

tric Materials and Devices—Properties and Circuit Applications, (3) Nuclear Reactors and Radiation in Industry.

AIR FREIGHT by guided missiles within 10 years was predicted by Dr. Simon Ramo of Ramo-Wooldridge at a Princeton Univ. lecture sponsored by the American Rocket Society.

LOGISTICS RESEARCH, INC. delivered the third ALWAC digital computer in as many months this year. The customer was North American Aviation. Yearly production rate has been doubled from 12 to 24.

NBS has published a report on its investigations of the role oxygen plays in adherence of vitreous enamel to iron.

SALT BATH INSTITUTE is a new trade association recently formed in Cleveland for manufacturers in the salt bath industry. Edward N. Case, Sales Manager, Ajax Electric Co., Philadelphia, was elected its first president.

Stock Report

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York

New York Stock Exchange:

	Price Range for 1956 Thru March 29		As of March 29
Security	High	Low	Last
Aeroquip Corp.	14 3/8	12 1/8	12 7/8
American Chain & Cable	46	38 1/2	44 5/8 - 45 (1)
American Mach. & F.	29 3/4	24 1/8	28 3/4
American Mach. & M.	40 3/4	35 1/8	39 5/8
American Optical	40 3/4	35 1/2	37 1/4
Beckman Instruments	31 1/2	25 1/8	29 3/4
Bell & Howell	33	28 1/4	31 1/4
Bendix Aviation	58 1/4	49 1/4	55 1/8
Bulova Watch	23	20 3/4	21 1/4
Burroughs	38	28 1/2	37 3/4
Clevite	24 1/4	20 3/4	22 5/8
Dobeckmun	36	31 3/4	35
Gamewell	30 5/8	25 5/8	28 3/4
General Inst.	10 1/8	8 1/2	9
General Prec.	53 1/2	45 3/4	48 3/8
General Time	32 7/8	29 1/2	32 - 32 1/2 (1)
Hamilton Watch	23 1/4	19	23 1/8
International Business Mach.	500	373	495
Minneapolis-Hon.	78 3/4	58	78
National Cash Reg.	43 3/8	34 1/8	41 7/8
Radio Corp.	50 3/8	41 1/8	48 3/8
Raytheon	19 1/2	15 3/4	17
Robertshaw-F.	28	25	26 1/2
Sangamo Electric	37 1/2	29 1/2	37 1/2
Sperry Rand	28 7/8	24	28 5/8
Square D	63 1/2	51 1/2	62
Starrett, L.S.	52 3/4	43 3/4	48
Sylvania Elec.	52 1/4	42	51 7/8
Telautograph	35	29	31 - 32 3/8 (1)
Texas Inst.	14	11 5/8	13 3/4
Underwood	44	35	42 5/8

(1) Bid - Asked price, no sale.

American Stock Exchange:

	Price Range for 1956 Thru March 29		As of March 29
Security	High	Low	Last
Air Assoc	13 1/2	9	11 1/8 - 12 1/4 (1)
American Meter	41	37 1/8	39 1/2
Benrus Watch	10 3/8	9 3/8	9 7/8
Breeze Corp.	9 1/8	6 5/8	8 3/4
Consolidated Electrodynamics	27 7/8	21	25 1/2
DuMont Labs.	10	8	8 5/8
ElectroData	20	13 1/2	18 1/4
Fairchild, C. & I.	24 3/8	21 5/8	21 5/8
Int'l Resistance	8 1/4	6 3/4	7
Lear Inc.	10 1/4	8 1/8	9 1/4
Nat'l Res. Corp.	25 1/4	17 7/8	24
Neptune Meter	34 7/8	28 3/8	30 1/4
New Haven Clock	2 1/2	2	2 1/4
Norden-Ketay	14 7/8	11 7/8	12 1/2
Pneumatic Scale	28 1/4	25 1/2	27 1/2 - 28 1/2 (1
Servomechanisms	9 1/2	8 1/4	8 1/2
Wallace & Tiernan	22 1/2	20	21
Waltham Watch	3	1 7/8	2 1/4

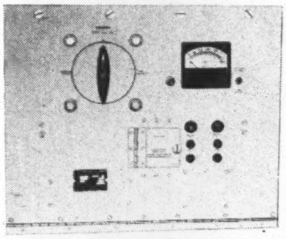
(1) Bid - Ask price, no sale.

New Standard
STABILINES

Meet Conditions Usually Considered as Special Applications

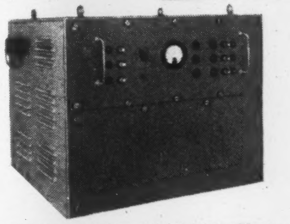
The "Unusual" is Usual for STABILINE* Automatic Voltage Regulators

DESIGNED FOR MIL-E-16400



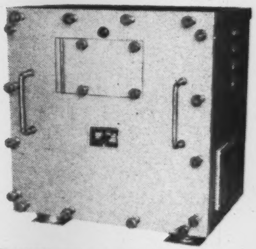
STABILINE TYPE EM10004 (Electro-mechanical)
INPUT: 195-255 volts, 50/60 cycles, single phase
OUTPUT: 230 volts, 24 KVA

MEETS MIL-E-4158



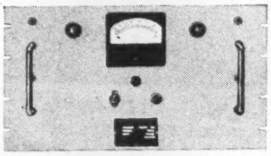
STABILINE TYPE EM10002 (Electro-mechanical) for Air Force land based installations.
INPUT: 105-135 volts, 55/65 cycles, three phase, 4 wire
OUTPUT: 120 volts phase to neutral, 55.5 amperes, 20 KVA, individual phase control

U. S. NAVY SPECIFICATIONS 16-E-4 AND 40-T-9



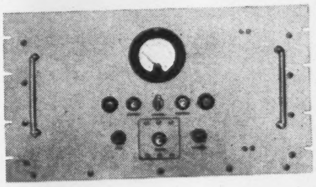
STABILINE TYPE EM10006 (Electro-mechanical) for applications involving shock and vibration requirements.
INPUT: 385-490 volts, 45/65 cycles, single phase
OUTPUT: 440 volts, 2.2 KVA

FOR NORMALLY LOW INPUT VOLTAGES



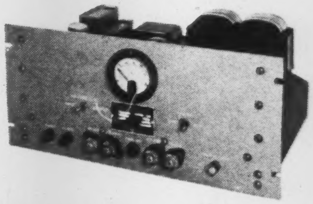
STABILINE TYPE EM10003 (Electro-mechanical)
INPUT: 80-115 volts, 50/60 cycles, single phase
OUTPUT: 115 volts, 2.0 KVA

MEETS SPECIFICATION MIL-E-4158



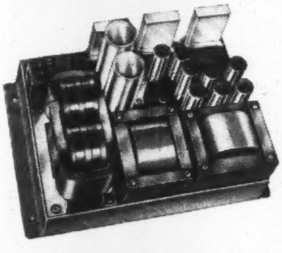
STABILINE TYPE EM10009 (Electro-mechanical)
INPUT: 187-229 volts, 410 cycles ±5%, three phase, 4 wire
OUTPUT: 203-213 volts, 14.0 amperes, 5.0 KVA

FOR MILITARY APPLICATIONS



STABILINE TYPE IE20003 (Completely Electronic) with no moving parts.
INPUT: 95-135 volts, 60 cycles ±10%, single phase
OUTPUT: 115 volts nominal, adjustable 110-120 volts, 8.5 amperes, 1.0 KVA

WITHSTANDS HIGH HUMIDITY



STABILINE TYPE IE20002 (Completely Electronic) with no moving parts.
INPUT: 190-250 volts, 50/60 cycles, single phase
OUTPUT: 230 volts, 150 VA

Check the characteristics of these new STABILINE Automatic Voltage Regulators against your "special" requirements involving automatic voltage regulation. You may find that you no longer need to look for special equipment. These units are standard STABILINES as are numerous other units with rated capacities from 0.25 KVA to 100 KVA. Look to SUPERIOR ELECTRIC for the solution to your automatic voltage regulation problems.

Be sure to see Superior Electric's MOBILE DISPLAY when it is in your area.

*Trade Mark Reg. U. S. Pat. Off.

14663 Titus St., Van Nuys, Cal. • P.O. Box 946, 2881 El Camino Real, Redwood City, Cal. • 482-B Eglinton Ave., West, Toronto 12, Ontario, Can. 2217 Biscayne Blvd., Miami 37, Florida • P.O. Box 48, 721 So. Blvd., Oak Park, Ill. • 4033 W. Rogers Ave., Office #2 Tippett Bldg., Baltimore 15, Maryland 250 Park Ave., Rms. 502-504 Postum Bldg., New York 17, N. Y. • P.O. Box 132, 101 Public Sq., Medina, Ohio • 4515 Prentice St., Room 201, Dallas 6, Texas.

THE SUPERIOR ELECTRIC COMPANY
705 MIDDLE STREET, BRISTOL, CONNECTICUT

Please send prices and more facts on STABILINE Automatic Voltage Regulators ☐ Please have representative call ☐

Name..
Company Name..................................
Address.......................................
City......................... *Zone*.... *State*..............

For more information circle 32 on inquiry card.

Here's why it pays to know your HSM

HONEYWELL SUPPLIES MAN

D. A. Somers, Honeywell Supplies Man in the Philadelphia area, shows Harry Baldwin, purchasing agent of Ajax Engineering Corp., Trenton, N. J., the type of Brown thermocouple protecting tube that will give long life and high sensitivity in an aluminum melting furnace.

Personalized service is the foundation of the HSM Plan. Your HSM man gives you valued assistance not only in selecting the right pyrometer supplies, but also in setting up a custom-fitted plan for buying that can cut your inventories, simplify purchasing . . . and save you a big percentage of your annual supplies bill.

Hundreds of companies are now using this Plan. Your nearby HSM will be glad to discuss how it can work in your own plant . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Aves., Philadelphia 44, Pa.

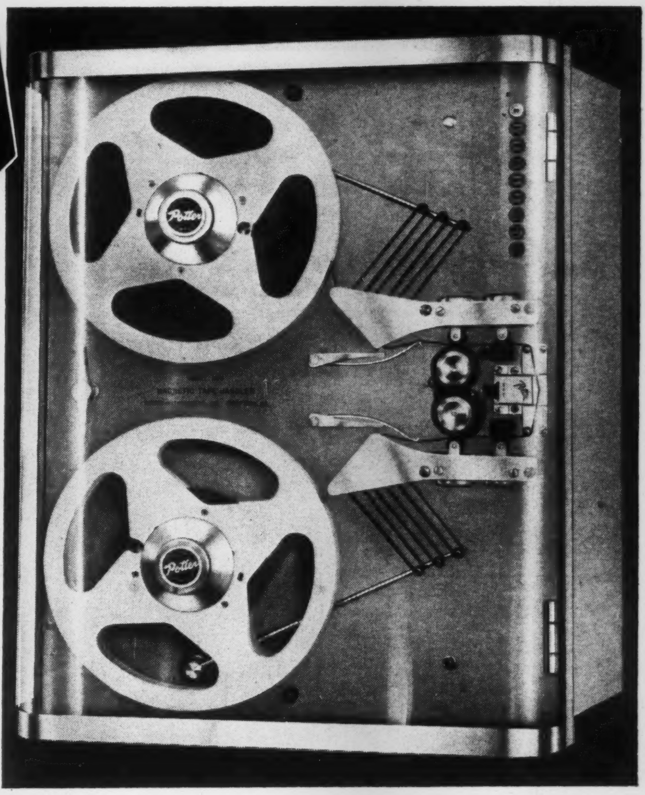
H
HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

Brand New!

POTTER Model 905 Digital Magnetic Tape Handler



- 75 inches per second
- 3 msec starts and stops
- automatic threading
- fast rewind

The Potter Model 905 Digital Magnetic Tape Handler combines many features not available on similar, more costly machines. A variety of dual speed combinations up to 75″/sec is available. Tape widths from ¼″ to 1¼″ can be accommodated.

Ease of operation is assured by simplified in-line threading, bi-directional high-speed rewind, automatic end-of-tape stopping and control of all machine functions by conveniently-grouped front panel push-buttons or remote contact closures and pulses.

Designed for standard 19″ rack mounting, the hinged front panel provides immediate access to mechanical parts and all plug-in electronic components. Transparent dust covers are available for protecting tape and mechanical parts without hindering visual observation of entire tape track.

The 905 represents the ultimate in digital tape handlers for high-speed computers, electronic business machines, industrial control and other digital data-handling applications.

AUXILIARY EQUIPMENT

A complete line of digital data-handling accessories is also available from Potter.

Record-Playback Heads (Model 6400) are available in a wide variety of channel number and tape width combinations. All feature phosphor bronze construction that eliminates digit "drop outs" caused by oxide pickup and insures dimensional stability.

Record-Playback Amplifiers can be furnished as individual plug-in units (Models 52, 53) or in complete record-playback systems (Model 920) for return-to-zero or non-return-to-zero recording.

Shift registers, high-speed printers and other precision engineered data-handling components are also available separately or in integrated systems for solving specific data-processing problems.

POTTER ENGINEERS welcome an opportunity to study your data-handling problems and to recommend equipment for satisfying your needs. Write today.

Potter POTTER INSTRUMENT COMPANY, INC.
115 Cutter Mill Road
Great Neck, L. I., N. Y.

For more information circle **34** on inquiry card.

← Circle **33** on inquiry card.

Paths to Success
FOR
ENGINEERS & PHYSICISTS
Burroughs

Every path to success

. . . each highway to achievement . . . must have a beginning and what better place to start than right here . . . in the new ultra-modern multi-million dollar Research Center which is only one of three erected in the immediate area within the past 3 years.

Located on Philadelphia's Main Line, within sight of historic Valley Forge, Burroughs multi-unit Research Laboratories are less than an hour by train or car over express highways to Philadelphia where cultural and educational facilities of known merit are available to engineers interested in advance study at The University of Pennsylvania, Drexel Institute or Temple University during the evening hours.

Naturally, a retirement program and other benefits for you and your family are part of Burroughs Progressive Employment Policies. So, too, is association with outstanding men in the business machine field.

Looking to future expansion, Burroughs invites inquiries from those qualified as:

ELECTRICAL ENGINEERS • PHYSICISTS • ELECTROMECHANICAL ENGINEERS

MECHANICAL ENGINEERS • TECHNICIANS • MECHANICAL DESIGN ENGINEERS

. . . in the following fields — Control Computers, Pulse Circuitry, Digital Computers, Optical Devices, High Speed Mechanisms, Guided Missiles, Solid State Circuitry, Electronic Packaging, Electrographic Recording Devices.

Burroughs
CORPORATION
RESEARCH CENTER
PAOLI, PA., NEAR HISTORIC VALLEY FORGE

Send Complete Resumé to
M. E. JENKINS
PLACEMENT MANAGER
For Interview at Your Convenience

New Plants and Mergers

ELECTRODATA CORP., subsidiary of Consolidated Electrodynamics Corp., and **BURROUGHS CORP.** announce an agreement, yet to be voted on by directors and stockholders of Electrodata, whereby Electrodata Corp. will combine with Burroughs Corp. Directors and stockholders will be asked to approve a plan whereby one share of Burroughs common stock will be issued for each two shares of outstanding Electrodata stock.

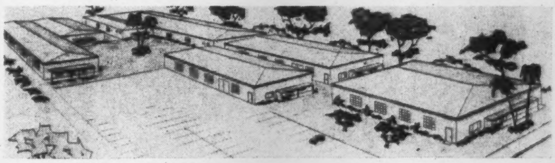
BARTON INSTRUMENT CORP. has begun construction on a 30,000-sq-ft plant which will cost over $200,000, in Monterey Park, Calif.

BROOKFIELD ENGINEERING LABS., INC., Stoughton, Mass., announces plans for a 50% expansion of plant facilities.

AIRMATIC VALVE CO., Cleveland, has tripled plant facilities, announces *Lawrence Gardner*, president.

AIRMATIC VALVE inc.

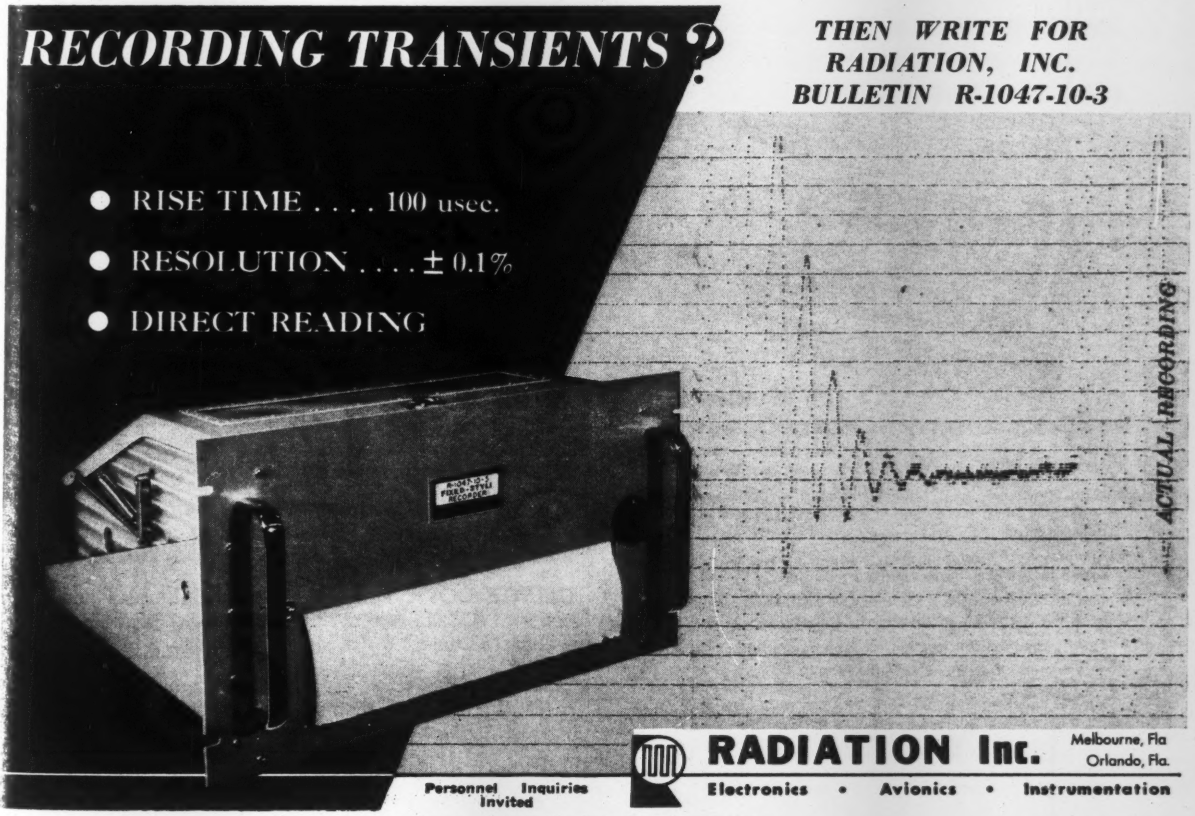
ARGA DIV., Beckman Instruments, Inc., announces plans to move to Costa Mesa, Calif., this year. The Division will ultimately occupy 45,800-sq-ft of manufacturing and office space in Costa Mesa.



SORENSEN & CO., INC., Stamford, Conn., announces merger of their European subsidiary, Sorensen Ltd. of Zurich, Switzerland, with Applied Research and Development Ltd.

ERIE RESISTOR CORP. announces a license agreement under which Speer Carbon Co., St. Mary's, Pa., will manufacture Erie's packaged assembly circuit known as PAC.

BOURNS LABORATORIES, Riverside, Calif., has opened a new 12,000-sq-ft factory in Ames, Iowa.



RECORDING TRANSIENTS?

- RISE TIME . . . . 100 usec.
- RESOLUTION . . . . ± 0.1%
- DIRECT READING

THEN WRITE FOR RADIATION, INC. BULLETIN R-1047-10-3

RADIATION Inc. Melbourne, Fla Orlando, Fla.

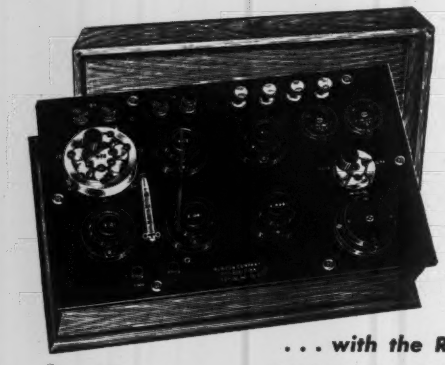
Electronics • Avionics • Instrumentation

Personnel Inquiries Invited

For more information circle 36 on inquiry card.

Precise

TEMPERATURE MEASUREMENTS



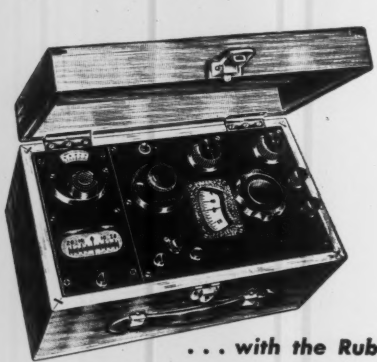
. . . with the Rubicon

MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



. . . with the Rubicon

PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer—permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

RUBICON COMPANY

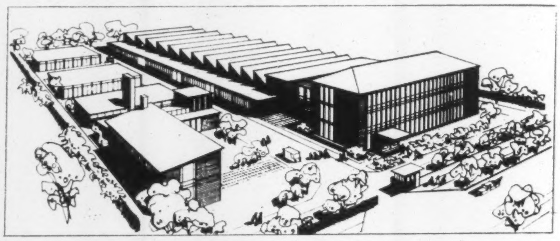
Electrical Instrument Makers

3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **37** on inquiry card.

PLANTS—CONTINUED

BECKMAN INSTRUMENTS, INC., announces acquisition of a site in Munich, Germany, for a $300,000 plant to manufacture Beckman products for Western Europe.



FIELDEN INSTRUMENT DIV., Robertshaw-Fulton Controls Co. has appointed H. G. Klug Co. to handle sales in Iowa.

CLARY CORP., Automatic Controls Div., announces an increase in production and engineering facilities as a result of increased orders for guided missile and aircraft components.

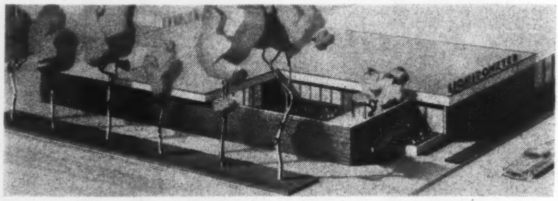
AUTOMATIC CONTROL CO., St. Paul, Minn., announces addition of new plant which will increase floorspace by 23,000 sq ft.

CONVAIR DIV., GENERAL DYNAMICS CORP., Pasadena, has concluded a licensing agreement whereby Consolidated Electrodynamics will manufacture and market Convair's shock-testing machine, and CEC's Consolidated Vacuum Div. in Rochester, N. Y. will manufacture the instrument.

ROBERTSHAW-FULTON CONTROLS CO. net sales for 1955 totaled $64,032,957, an increase of 10% over 1954. Net earnings amounted to $2.51 per share, compared with $2.50 per share in 1954.

G. M. GIANNINI & CO., INC. sales and earnings for 1955 reached a record high, with sales in excess of $6.4 million and net income of $290,787.

LIQUIDOMETER CORP., LIC, N. Y., announces construction of a 4,500-sq-ft engineering and sales office in Los Angeles, Calif.



J. I. MORRIS CO., Southbridge, Mass., announces completion of two-story 6800-sq-ft brick addition to their plant.

CLEVITE CORP. announces record-high sales and revenues of $73,088,935 for the year 1955 and net profit of $4,854,753, equal to $2.54 a share.

HELIPOT CORP., S. Pasadena, Calif., announces appointment of Allen I. Williams Company as engineering sales representative.

J. F. PRITCHARD AND CO.—*Hugh E. Robertson*, adv. mgr., announces appointment of the Frank K. Donnelly

NOW 1 VERSATILE UNIT

any MEASURES VARIABLE

which can be resolved into capacitance change

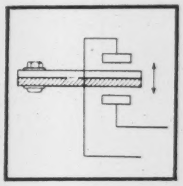
The *decker* DELTA UNIT....

Here is a capacitance-to-voltage analog transducer so versatile that its usefulness is as limitless as your own imagination.

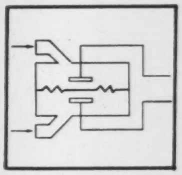
Utilizes the T-42 IONIZATION TRANSDUCER

MEASURE	Displacement (linear or angular) (micrometric or macrometric) Pressure Temperature Dielectrica Liquid level Vibration, etc.
DISPLAY **RECORD** **CONTROL**	variables with a simplicity, versatility, flexibility and low cost never before possible in capacitive gaging
SENSITIVITY	as high as 5 volts per $\mu\mu F \Delta c$, with a phase sensitive d-c output signal as high as ±60 volts, yet stable enough to measure 0.01 volts.
TO OPERATE	just provide a simple power supply and indicator . . . connect the desired capacitance configuration to the DECKER DELTA UNIT . . . and an analogous output signal is immediately available.

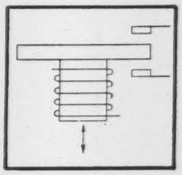
TEMPERATURE



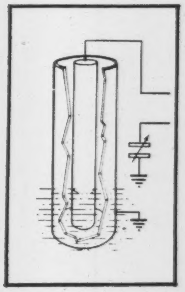
PRESSURE



VIBRATION



LIQUID LEVEL



Detailed information on the DECKER DELTA UNIT—priced at $115.00, complete with probe and cable—is in Instrument Data Sheet 901-1, available upon request to Technical Literature Section.

decker AVIATION CORPORATION

1361 Frankford Ave., Philadelphia 25, Pa., PHONE GArfield 5-2300

For more information circle **38** on inquiry card.

You get dependability PLUS in Moeller

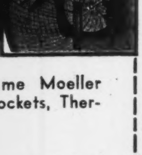
Thermo-wells
Separable Sockets
Thermo-Couple
Protecting Wells
and Tubes

because . . .
our business is the
design and manufacture of
temperature measuring
instruments . . .
and has been since 1867.

Close to 90 years
of experience in this field
has made the name of
MOELLER the standard of
accuracy and reliability.

For information on these
precision products
made by Moeller
mail the coupon, today.

MOELLER
INSTRUMENT COMPANY
132nd ST and 89th AVE
RICHMOND HILL 18 N Y
Representatives in Principal Cities



Gentlemen: Without obligation, please send me Moeller Catalog No. 150 on Thermo-Wells, Separable Sockets, Thermo-Couple Protecting Wells and Tubes.

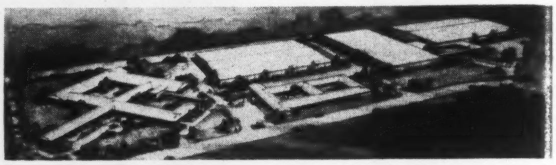
NAME ....
FIRM ....
ADDRESS ....
CITY .... ZONE .... STATE ....

For more information circle 39 on inquiry card.

Co., Seattle, as sales representative in the state of Washington.

TELECOMPUTING CORP., N. Hollywood, Calif., announces acquisition of all outstanding stock of Wittaker Gyro, Inc., in exchange for authorized but unissued Telecomputing stock.

VARIAN ASSOCIATES, Palo Alto, will begin construction of new buildings that will more than treble the company's floor space over the next few years. Varian has extended its lease in the Stanford Industrial Park to 33 acres.



FRIDEN CALCULATING MACHINE CO., San Leandro, Calif. announces plans to purchase Commercial Controls Corp. of Rochester, N. Y. for about $7,000,000 worth of Friden stock.

NUCLEAR SCIENCE AND ENGINEERING CORP., Pittsburgh, Pa., announces building of a new 3½-acre laboratory facility near Allegheny County Airport.

THE GAMEWELL CO., Newton Upper Falls, Mass.—*John T. Bales*, sales manager, announces representatives for the newly formed Precision Potentiometer Division: Electrical Manufacturers Service, East Meadow, N. Y.; Engineered Sales Co., Chicago, Ill.; Robert W. Gray, Inc., Boston, Mass.; G. E. Moxon Sales, San Mateo, Calif.; M. K. Widdekind Co., Seattle, Washington; Robert B. Stahlhut, St. Louis, Mo.; Northern Electric Co., Belleville, Ontario; and export sales by Hudson-Randall International, N. Y.

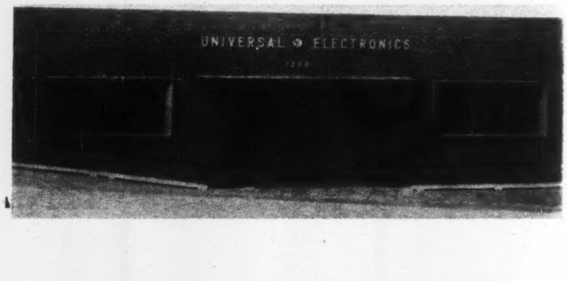
MASON-NEILAN REGULATOR CO. announces re-location of main office and factory to newly constructed building on Nahatan St., Norwood, Mass.

NEELY ENTERPRISES, N. Hollywood, announces opening an office in Las Cruces to serve the southern part of New Mexico.

BAIRD ASSOCIATES, INC. and **ATOMIC INSTRUMENT CO.**, Cambridge, announce agreement on terms of a merger by representatives of the companies—subject to formal action by boards of directors and stockholders. Baird announces sales of $700,000 for first quarter of fiscal 1956.

ELECTRO TEC CORP., S. Hackensack, N. J., announces its integration with Electro Tec of Florida, Inc. and Instrument Corp. of America, Blacksburg, Va.

UNIVERSAL ELECTRONICS CO., Santa Monica, Calif., announces completion of their new factory, now in full operation at Santa Monica, Calif.



NEW DEPARTURES OF TODAY

Ultra-precise *miniature* ball bearings!

Look to New Departure—with its expanded facilities—for a full line of miniature ball bearings, 3/8″ (.375″) outside diameter and smaller.

These tiny steel "jewels" are made with extreme accuracy on the finest equipment available . . . assembled, torque-tested, and packed in pressurized, atmosphere-conditioned areas of surgical cleanliness . . . to assure performance and dependability matching the most exacting needs of today's precision industries.

For full information about miniature bearings, or for engineering help on your bearing problems, call or write New Departure, Division of General Motors Corporation, Bristol, Conn.

WRITE FOR NEW DEPARTURE'S MINIATURE BEARING CATALOG

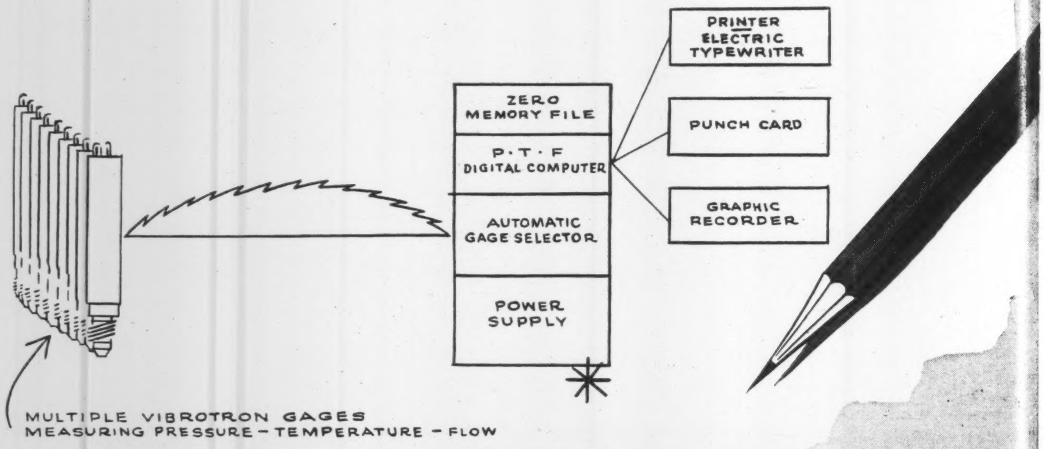
GM GENERAL MOTORS

NEW DEPARTURE
BALL BEARINGS

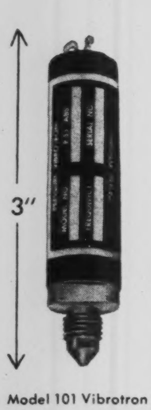
NOTHING ROLLS LIKE A BALL

For more information circle **40** on inquiry card.

Make your system COUNT!


PRINTER
ELECTRIC TYPEWRITER
ZERO MEMORY FILE
P·T·F DIGITAL COMPUTER
PUNCH CARD
AUTOMATIC GAGE SELECTOR
GRAPHIC RECORDER
POWER SUPPLY
MULTIPLE VIBROTRON GAGES
MEASURING PRESSURE – TEMPERATURE – FLOW

BJ DIGITAL SYSTEMS



Model 101 Vibrotron

INDICATE, RECORD AND CONTROL pressure, temperature and flow with BJ Digital Systems. It's as simple as 1-2-3. ONE, BJ Vibrotron Digital Gages at remote points use frequency changes to measure pressure, temperature or flow (P-T-F) and signal this information by direct wire or radio link. Two, these frequency signals are received and directly indicated in numbers on the BJ P-T-F Digital Computer without further translation. THREE, this information in numbers can then be fed to any desired recording device or used to initiate control action and close the loop.

Only digital systems give you the direct simplicity of information in *percentage* by numbers from 000 to 999. Thus, all information has a common denominator. Variations in performance are *counted* and not compared.

The heart of BJ digital systems is the BJ Vibrotron Gage which uses a vibrating wire under tension. Pressure, temperature and flow control the tension and frequency signal.

Other Byron Jackson digital system components include: a Zero Memory File which permits simple electronic calibration of all sensing gages in the system; and an Automatic Gage Selector which sequentially selects signals from any number of gages for measurement by the P-T-F Digital Computer.

Investigate BJ digital equipment before you make a decision on your systems problem. BJ electronic engineers are ready to help you make your system *count*.

Send for special technical data file on "Make Your System Count."

BJ

Byron Jackson

DIVISION OF BORG-WARNER CORPORATION

492 East Union Street • Pasadena 1, California

For more information circle **41** on inquiry card.

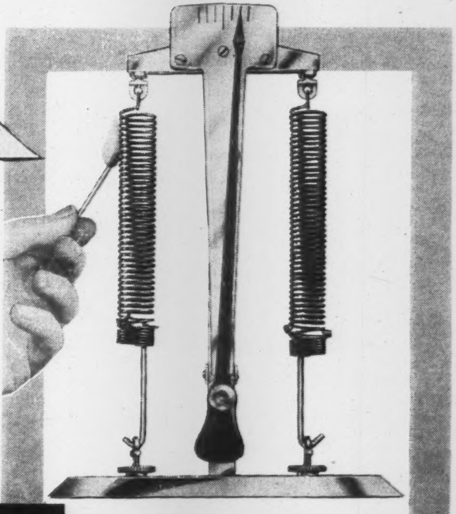
CHATILLON guarantees to improve your product!

THIS DRAMATIC MATCH TEST PROVES CHATILLON ISO-ELASTIC* SPRINGS UNAFFECTED BY TEMPERATURE CHANGES

This testing unit shows the effect of temperature on usual spring materials as compared to Chatillon's exclusive Iso-Elastic alloy! Steel spring is attached to left of crossbar balanced by an equal strength Iso-Elastic spring at right. Any change of strength of either spring will cause pointer to move.

Match flame is run along Iso-Elastic coils 10 seconds. Pointer remains centered without fluctuating.

*U.S.A. Pat. No. 2174171



Match flame is run up and down coils of steel spring for 10 seconds. Pointer moves away from zero reading.

When ordinary spring materials are subjected to either an increase or decrease in temperature, the modulus of elasticity either increases or decreases, thereby changing the strength of the spring.

Chatillon Iso-Elastic, however, has a constant thermal coefficient of the modulus of elasticity and springs made from this revolutionary alloy maintain constant strength throughout temperature ranges from —150°F to +150°F.

Have a Chatillon engineer demonstrate this remarkable test for you without obligation. Iso-Elastic can improve the accuracy of your spring activated instruments. Engineering bulletins available upon request.

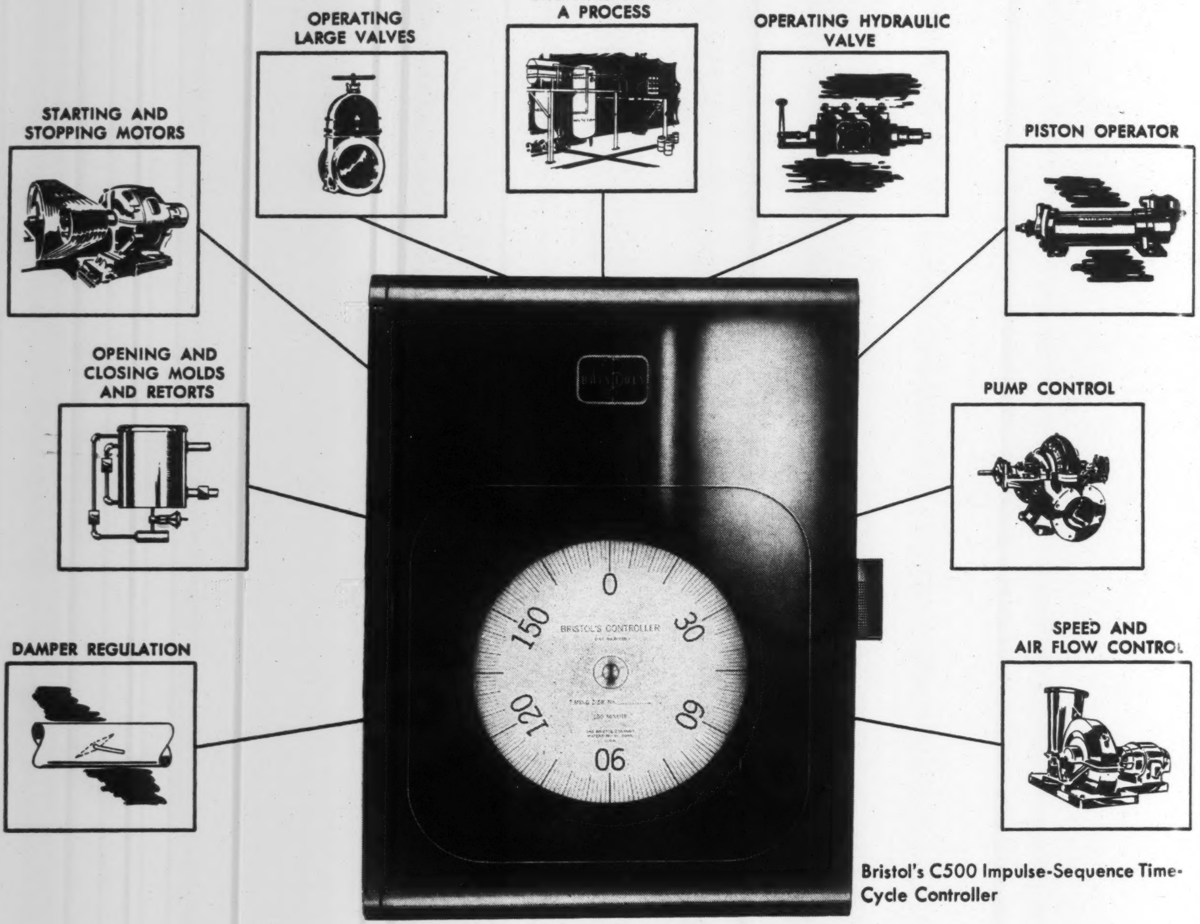
JOHN CHATILLON & SONS

85 Cliff Street, New York, N. Y.

Manufacturer of Precision Springs and Measuring Apparatus Since 1835

For more information circle **42** on inquiry card.

WHAT'S NEWS AT BRISTOL . . .


SHUTTING DOWN A PROCESS
OPERATING LARGE VALVES
OPERATING HYDRAULIC VALVE
STARTING AND STOPPING MOTORS
PISTON OPERATOR
OPENING AND CLOSING MOLDS AND RETORTS
PUMP CONTROL
DAMPER REGULATION
SPEED AND AIR FLOW CONTROL
BRISTOL'S CONTROLLER
0
30
60
90
120
150

Bristol's C500 Impulse-Sequence Time-Cycle Controller

AUTOMATIC TIMING . . . THE KEY TO AUTOMATION

In almost every plant you'll see operations that *must* be carried out according to definitely timed sequences.

Experience has shown that such operations can be controlled with greater precision by automatic time-cycle controllers than by any other method—and when accurate timing is *continuously* maintained, here are the happy results:

- production from given installed equipment is increased
- uniformity of product is assured
- rejections are almost wholly eliminated
- operators are released for other important duties

Automatic control also puts the process under direct measurement—which means that operating conditions are more easily determinable and more easily reproduced.

Which controller should you select? Hundreds of leading industrial firms, many of them Bristol customers for over 66 years, are using Bristol Automatic Process-Timing Controllers. Our engineers have had long experience in the application of Automatic Process-Timing Controls in practically every industry. They're ready to work on your problem now. Write today for our Bulletin C305. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 6.20

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **43** on inquiry card.

People IN THE NEWS

BALDWIN-LIMA-HAMILTON CORP., Philadelphia, Pa., announces election of *Milton Steinbach*, N. Y. C., member of Wertheim and Co., and *Henry Barnhart*, Lima, Ohio, Vice President in charge of the B-L-H Construction Equipment Div., as members of the Corporation's Board of Directors. Other appointments include *Robert R. Lent* as west coast coordinator for Electronics and Instrumentation Div. in the guided missile program, and *Herbert L. Newlin* as purchasing agent for the Eddystone Div.

AMERICAN METER CO., INC., Philadelphia, Pa., announces naming of *James H. Judge* as assistant to the president.

James H. Judge
American Meter

Richard D. Adams
North Shore Nameplate

NORTH SHORE NAMEPLATE, INC. announces appointment of *Richard D. Adams* as Vice President and General Sales Manager.

NORDEN-KETAY CORP., N. Y., announces election of *Louis Ten Eyck Thompson* as vice president for research.

GENERAL CONTROLS CO., Glendale, Calif., announces naming of *John Pachyn* as assistant sales manager for Industrial Controls Div., *Bruce Grimm* as chief engineer for Precision Potentiometer Div., *Gorden F. Walker* as manager of field engineering and *Richard J. Wickert* as field engineer for Perfex Div.

PERKIN-ELMER CORP., Norwalk, Conn., announces election of *Roderic M. Scott* as vice president in charge of the newly formed Engineering and Optical Division, and *Van Zandt Williams* as general manager of the newly formed Instrument Div.

Van Zandt Williams
Perkin-Elmer Corp.

Arthur O. Black
Magnetics, Inc.

MAGNETICS, INC., Butler, Pa., announce election of *Arthur O. Black* as president and *William D. Dickey* as executive vice president.

IT PAYS TO SPECIFY **STANDARD** FIXED RESISTORS

99% of all modern circuit requirements can be met fastest and most economically by Stackpole ½, 1 and 2-watt fixed composition resistors in the standard, RETMA preferred values. By specifying them, you are assured of fast deliveries, lowest prices and fewer stocking problems. Write for handy wall chart specifying these standard values: *Electronic Components Division* Stackpole Carbon Co., St. Marys, Pa.

STACKPOLE

FIXED & VARIABLE RESISTORS • SLIDE SWITCHES • IRON CORES
CERAMAG® FERROMAGNETIC CORES • MOLDED COIL FORMS
GA LOW-VALUE CAPACITORS • CERATAB® PRINTED CIRCUITS

For more information circle **44** on inquiry card.

WINZELER
Stamped Gears

Get Greater Accuracy In Your Stamped Gears

EACH WINZELER STAMPED GEAR, in runs of hundreds or *thousands*, equals or surpasses the most exacting specifications. They invariably cut assembly time, and costs. Mechanisms run smoother, sweeter, longer. And users like the quiet, dependable performance of WINZELER Geared products. Send along drawings, specifications, quantities needed. Let our capable staff help you.

SEND FOR ***useful 4-page folder . . a valuable Stamped Gear guide. Gives technical data, tables, ideas, suggestions, descriptions of many types. Use company stationery please!***

WINZELER MANUFACTURING & TOOL CO.
1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

For more information circle **45** on inquiry card.

MODEL 1301

BORG MICRODIAL

DIRECT READING THROUGH 3600° TO A DIGITAL ACCURACY OF 1 PART IN 1000.

FITS ANY MULTI-TURN DEVICE HAND OR SERVO OPERATED

● The new direct reading Borg Microdial Model 1301 practically eliminates human error because it was designed for forced fast reading. Laboratory, production and processing controls become more accurate when clear, sharp, figures on the specially designed Borg Counter are observed through the focal-point window. Borg Counter figures are seen against a dull black background to provide maximum contrast for instant perception under difficult reading conditions.

The specially designed Borg Counter in the Model 1301 Borg Microdial reads from 000 to 999 to 000 in 3600 degrees of continuous rotation with no stops. Maximum recommended operating speed is 10,000 counts per minute (100 rpm).

Designed for military application, it has a built-in dust shield and clear-vision, wide-angle window for accurate reading from almost any position in front of the dial.

The Model 1301 Borg Microdial is compact. It measures only 1-3/4″ in diameter and 1-5/8″ in height and occupies no more panel space than the Micropot it controls.

WRITE FOR CATALOG SHEET BED-A31

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

For more information circle **46** on inquiry card.

PEOPLE—CONTINUED

ARGA DIV., BECKMAN INSTRUMENTS, S. Pasadena, Calif., announces appointment of *Michael S. Dayton* as sales manager.

M. S. Dayton
Arga Div., Beckman

N. A. Flannigan
CEC

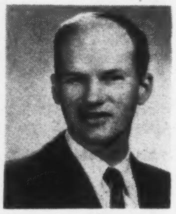
CONSOLIDATED ELECTRODYNAMICS CORP., Pasadena, Calif., announces appointment of *Norman A. Flannigan* as manager of advertising and public relations of Consolidated Vacuum Div.

ELECTRODATA CORP., Pasadena, Calif., announces appointment to its board of directors of *William E. Siegel,* vice-president of Security First National Bank of Los Angeles.

ALLEN B. DuMONT LABORATORIES, Clifton, N. J., honored *Harry C. Gawler* for twenty-five years of service as a DuMont representative; *Arthur H. Fogelman* is new assistant to the manager of Washington, D. C. office.

WHEELCO INSTRUMENTS DIV., BARBER-COLMAN CO., Rockford, Ill., announces the following staff expansions: *John B. Moore* and *Edward W. Sullivan* have joined the Phila. office; *James T. Shelton* has joined the Buffalo, N. Y. staff; and *Walter Golmore* is now associated with the New York office.

UNITEK CORP., Pasadena, Calif., has named *Robert P. Norton* as advertising and sales manager of Weldmatic Div.



R. P. Norton
Unitek Corp.

D. D. Seely
Farnsworth

FARNSWORTH ELECTRONICS CO., Ft. Wayne, Ind., announces appointment of *Douglas D. Seely* as manager of marketing administration and *J. Chester Kerr* as contracts manager.

HIGH VOLTAGE ENGINEERING CORP., Cambridge, Mass., announces appointment of *James H. Bly* to the sales division.

C. P. CLARE & CO., Chicago, Ill., announces appointment of *Ronald W. Price* as district sales manager of the new Canadian office in Toronto.

MANNING, MAXWELL & MOORE, Stratford, Conn., announces the following personnel changes: *Robert O.*

How to Control Heat in a Large Oven

No. 4 of a series — *Showing the Broad Application Range of Fenwal Controls*

The oven is designed to dry 30 yards of finished goods per minute at oven temperatures up to 400°F. The problem was to maintain the desired 330°F in the oven. Here's how this was accomplished —

The many electric heaters, which are distributed uniformly in the oven, provide a total heat input of about 60,000 watts and are divided into two separate control circuits. About one-third of the heaters are controlled by a simple on-off controller of moderate sensitivity to maintain a basic heat level in the oven. The remaining heaters are operated by the Fenwal Series 560 Portable Temperature Indicating Controller, an instrument of high sensitivity and rugged construction. The Series 560 provides the proportioned heat necessary for accurate control of the curing process. It also can be used for straight on-off control. Here's the way the control set-up works —

To maintain the desired 330°F in the oven, the on-off controller is set at 315°F, while the proportioning controller is set at 330°F. So both heater circuits are on during oven warm-up or when incoming fabric depresses the oven temperature below 315°F. Above 315°F, the on-off controller shuts off the heaters in its circuit, and the process heat is obtained from the remaining heaters under the control of the Fenwal Series 560 Controller.

Integrated Sensitivity a Big Advantage in The Series 560

In the Fenwal Series 560 Temperature Indicating Controller the superior thermoelectric qualities of the revolutionary thermistor are used to fullest advantage. The great resistance change of the thermistor in response to temperature change results in extreme sensitivity. It also enables the use of a simple null balance bridge circuit for increased stability. And it permits the use of a standard electric conductor as a connecting wire — *no special wire is required.*

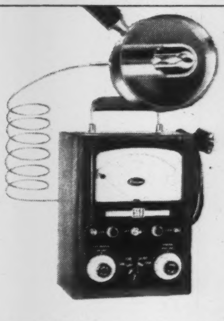
These characteristics have been *integrated* by Fenwal into a rugged, durable instrument which is the first to combine all three major modes of indicating control — on-off, proportional and adjustable differential — *all functioning with high sensitivity at the flip of a switch.*

THIS 600 CUBIC FOOT CURING OVEN, planned and installed by Atlas Textile Machinery Co., Paterson, N. J. at the Gsell Textile Printing Corp. plant in New York, uses the Fenwal Series 560 Portable Temperature Indicating Controller to provide uniform drying conditions within 2 degrees of the set point.

Proved Applications

Fenwal Sales Representatives and Engineers have saved time, trouble and money in all types of plants and laboratories by solving thousands of temperature control and detection problems. Fenwal THERMOSWITCH® units are controlling processes that involve liquids, gases and solids.

Put Fenwal's vast reservoir of technical know-how to work for you. Chances are your problem has already been met and mastered by Fenwal engineers. Write for Catalog No. 500 for complete information.



SERIES 560 INDICATOR CONTROLLER with magnified cutaway view of thermistor probe.

FENWAL INCORPORATED
365 Pleasant Street
Ashland, Mass.

Please send me your Catalog No. 500. Our specific problem is:..............................

....

....

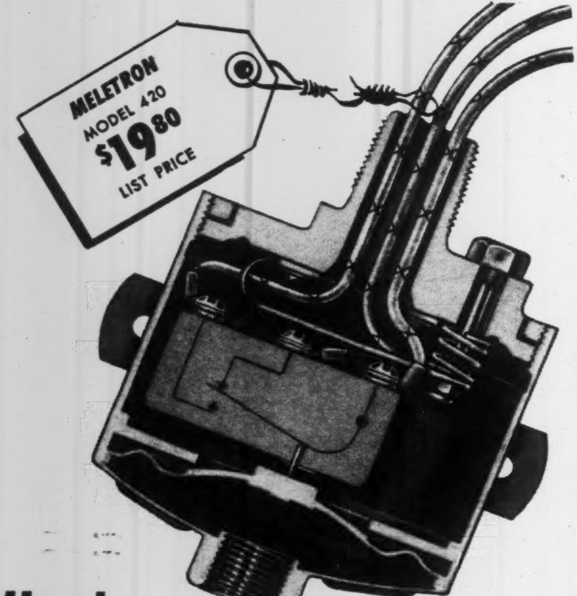
Name............*Title*..........

Address........................

City..........*Zone*...*State*.......

Fenwal **CONTROLS TEMPERATURE . . . *PRECISELY***

For more information circle **47** on inquiry card.



Here's the Simplest Diaphragm Pressure Switch

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

To get complete specifications and operating data ask for bulletins 420- 421

BARKSDALE VALVES
PRESSURE SWITCH DIVISION
5125 Alcoa Avenue, Los Angeles 58, California

For more information circle 48 on inquiry card.

PEOPLE—CONTINUED

Wilson has been transferred to the Phila. office, *John E. R. Johnson* has joined the Chicago office, *Maurice F. Hyett* has joined the Houston office and *Jack L. Gates* has been transferred to the Tulsa office.

GENERAL ELECTRIC CO., Schenectady, N. Y., announces the Research Laboratory's European office will be permanently located at Pelikanstrasse 37, Zurich 1, Switzerland, under the direction of *Dr. George J. Szasz.*

STROMBERG-CARLSON DIV., General Dynamics Corp., Rochester, N. Y., announces appointment of *Malcolm P. Herrick* as staff assistant to *John V. Voss*, vice president in charge of the Telephone Div.

THE BRISTOL CO., Waterbury, Conn., announces appointment of two new district managers: *L. B. Lumpkin*, Pittsburgh office; *W. C. Petersen*, Birmingham office.

L. B. Lumpkin
Bristol Co.

W. C. Petersen
Bristol Co.

SORENSEN & COMPANY, INC., Stamford, Conn., has named *Julian M. Polis* to manage a new West coast office in Hollywood, Calif.

NATIONAL BUREAU OF STANDARDS, Wash., D. C., announces appointment of *John L. Dalke* as Chief of High Frequency Impedance Standards Section and selection of *Robert J. Kurland* for the Postdoctoral Research Associateship program. *John G. Thompson*, Chief of the Metallurgy Div. has retired after more than 35 years of government service. *James I. Hoffman* has been named to replace him.

FISHER GOVERNOR CO. LTD., Lewisham, England, announces appointment of *H. R. Walton,* sales manager, as a director.

ELECTRONIC ENGINEERING CO., Los Angeles, Calif., announces arrangements with Electronic Systems Development Corp., Ventura, Calif., for technical consulting services of two German scientists: *Otto G. Schwede* and *Theodor F. Strum.*

VITRO CORP. OF AMERICA, New York, N. Y.—*J. Carlton Ward, Jr.*, president, announces election of *Frank B. Jewett, Jr.*, as vice president and member of the board.

ARTHUR D. LITTLE, INC., Cambridge, Mass., announces election of *Raymond Stevens* as president, and Earl P. Stevenson as chairman of the board.

CLEVELAND INSTRUMENT CO. INC., Cleveland, Ohio, announces the appointment of *William Doonan* as midwestern sales manager for Mich., Ind., Ill., Wis., and western Ohio.

Large OD Thin Wall Tubing offers New Answers to Design Problems

Superior specializes in an unusually wide range of analyses, shapes and sizes

Today's design engineers are finding large OD thin wall tubing by Superior answers more and more of their design problems. Its light weight makes it ideal for ducting, fuel and oil lines in aircraft. Thin wall tubing also functions efficiently as a low pressure heat exchanger tube. Because of its close tolerances, ductility, and bright, clean OD and ID surfaces, Superior thin wall tubing is an excellent choice for flexible metal hose for the food, chemical and aircraft industries. Other applications include bellows, solenoid cylinder cores, cylinder liners for automobile hydraulic brakes, fractional horsepower motor casings, ceramic drills, electron power tube anodes and cathodes, and casings for radioactive well logging instruments.

A number of analyses in large OD thin wall seamless and Weldrawn® tubing are available at Superior. Stainless, carbon and alloy steels, beryllium copper, titanium, nickel and nickel alloys are offered in sizes up to 1⅛″ OD with .035″ wall maximum; Monel and certain analyses of stainless steel in sizes to 2½″ OD with .025″ wall maximum.

Superior tubing can be supplied in random, multiple or cut lengths up to 30 feet, and in any of three standard tempers (fully annealed, soft; half-hard drawn; full-hard drawn) or in special tempers required by Government, aircraft and customer specifications. Thin wall tubing can be shipped in special cardboard cylinders, to protect it from dents and scratches.

For additional information, get your free copy of Data Memorandum No. 4. Write to Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

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The big name in small tubing

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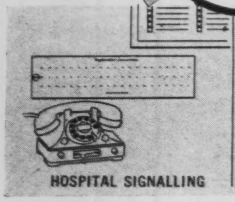

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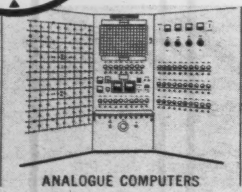

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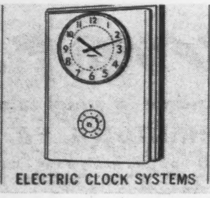

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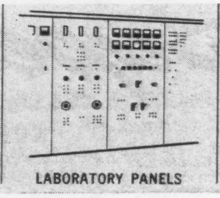

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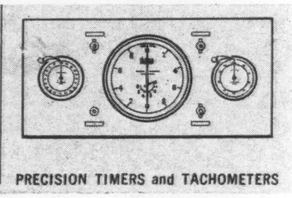

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INSTRUMENTS and AUTOMATION

Biographies of significance

SIGNIFICANCE

Robert L. Galley is a familiar name in the fields of flowmetering and rocket-engine test instrumentation. His reputation has been established in both process and aircraft instrumentation—no mean feat. We invite you to meet Bob, and to learn about the unique combination of education and experience that has led one man to important contributions in fields too often considered unique and separate. His biography also illustrates the instrument problems in the new and expanding field of rocket-engine test instrumentation, wherein he is now Rocket Engine System Instrumentation Coordinator, Rocketdyne Division, North American Aviation, Inc., Canoga Park, Calif. We are pleased to acknowledge Bob's important position in the field of modern instrumentation, and his contributions to it.

ROBERT L. GALLEY

Bob Galley's twenty-eight years of instrumentation started in June 1928 (the same year this magazine started its service to the instrument industry!) when he joined Bailey Meter Company's Cadet Engineering Course in Cleveland, Ohio, after graduation from the University of Michigan in mechanical engineering. He was married and his first-born was on the way when he left Ann Arbor.

His ambition at that time was to be a designer of power plants. However, the thorough training Bailey Meter gives their young engineers was destined to lead him instead into an instrumentation career, altho at that time he did not realize it. In the nineteen-twenties and -thirties, Instrument Engineering as a career was not included in any listing of "what to do when you get out of school." So, for the next 10 or 15 years he was a budding power plant engineer.

One of his eight years at Bailey was spent at Ohio State University, experimenting with water and steam flow through orifices. This first established his reputation as an expert in flowmeter engineering, a reputation that has followed him throughout his instrument career.

A thirst for practical power-plant experience carried him through the late thirties at B. F. Goodrich Co. in Akron and, at the start of World War II, he found himself back in instrumentation as a by-product of analyzing power-plant operations in various duPont explosives works. After selling instruments and controls for a year with Energy Control Co. in Wilmington, Delaware, and Baltimore, Maryland, he joined American Viscose Corporation's design group in their Philadelphia headquarters. Under Lyman H. Allen, Jr., then the rayon firm's first and only corporation-wide instrument engineer, he cut his eye-teeth on process controls. In the short span of three years at American Viscose, he and Lyman Allen advanced acceptance of a central instrument engineering staff to the point of specification and procurement of instruments.

In 1948 a worsening of his wife's health forced him to consider a drier climate, and so to the San Fernando Valley. He was brought to the west coast by North American Aviation, Inc. to become one-fourth of the instrument engineering force in the newly-formed rocket-engine test group. Here he tackled many new problems in flow measurement, supervising for several years a group of engineers and mechanics at the famous Santa Susana Propulsion

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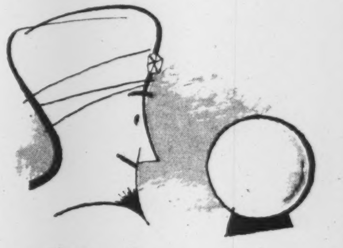

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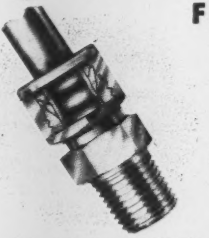

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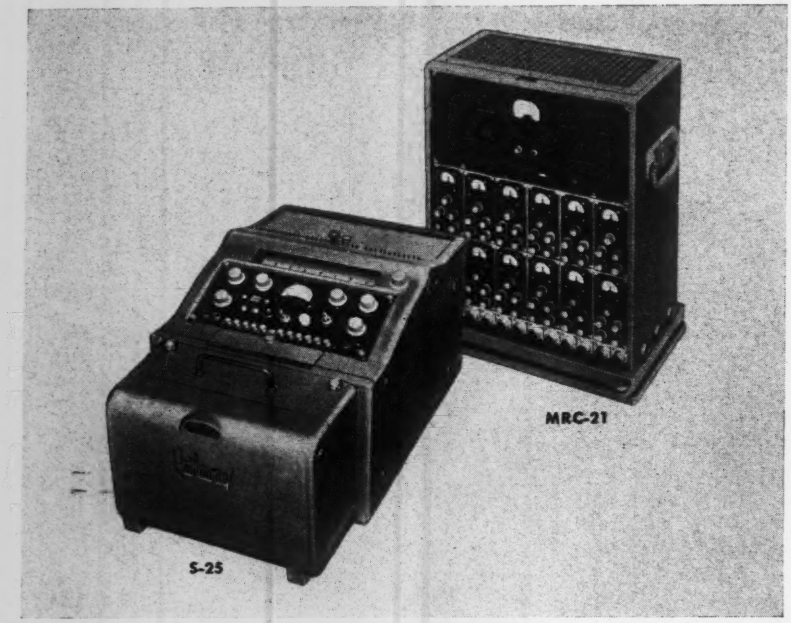

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BIOGRAPHIES —CONT.

Field Laboratory. (Today this is the free world's largest rocket-engine test facility, with an instrument engineering force numbering over 100).

He is now Rocket Engine System Instrumentation Coordinator at the new Canoga Park, California, Headquarters of NAA's Rocketdyne Division.

Instrumentation at Rocketdyne

At North American Aviation the prime consideration is the economical and accurate logging of engine pressures, temperatures, speeds and flowrates occurring during a short test of from a few seconds to several minutes. Faithful transient response is so important that a matter of several inches of line to a transducer can change the entire meaning of a pressure reading. Emphasis has been placed more and more on this factor of transient response, so that today all the important engine parameters are recorded not only by pen-and-ink instruments but also by photographic oscillographs, cathode-ray recorders and magnetic tape.

In progressive stages, evolution has brought (by development in NAA's own lab) many new and varied types of special instruments: optical types of liquid level probes, ignition failure devices, and bubble detectors; transformer and capacitance liquid-level gages; vortex detectors; mixture ratio recorders; "rough combustion" detectors which act faster than the human eye in shutting down an unsafe test, etc. The most ambitious development to date is the NAA "Datamaster," a tape-to-digit data logger and computer.

At the various data recording stations in the Rocketdyne Field Laboratory are row upon row of conventional Bailey, Brown and Foxboro single-pen recorders in both round- and strip-chart form. These analog instruments chart engine conditions at high paper speeds. It is common to find one group of 100 such instruments taking data during a "firing," while technicians are busily calibrating another large bank of recorders for the next firing. (You will find some typical NAA instrumentation activities on pages 906 and 907 of this issue, and we will bring you others on Rocketdyne activities in the near future.)

In the field of flowrate measurement (Bob's specialty), the present practice is to rely almost entirely on turbine-type flow sensors. At Santa Susana there are literally hundreds of these in all sizes from ½-inch up to 10-inch, measuring water, fuels, liquid oxygen and other fluids.

The trend in flowrate measurement today in rocket powerplant testing is, hopefully, toward a sensor with no moving parts in the pipe, because the failure of a turbine flowmeter could be disastrous. The ultrasonic and electromagnetic types appear most promising, altho the former is still too undeveloped for immediate use, while the latter do not work on hydrocarbon fuels or liquid-oxygen.

Bob says, "I have seen the impact of war-borne electronics industry on the instrument profession. We oldtimers grew up with cable-operated boiler dampers, on-off combustion controls, pressure measurement by Bourdon gages and temperatures by gas-filled and liquid-filled systems. Time constants once measured in minutes are now reckoned in milliseconds. I am proud to be associated with a branch of applied science which has done so much for so many in so short a time.

"But along with that I am deeply disappointed to note the lack of appreciation by top management in most basic industries of the professional stature of today's Instrument Engineer. Instrumentation is now of sufficient stature, maturity and importance to qualify as one of the basic divisions in today's industrial structure. No one professional society is doing more to promote this than the ISA, and no one publication has done more than *I&A*—which I have profitably read for almost 10 years. In fact, *Instruments and Automation,* one of the most important technical journals in this field today, was not only the first to 'beat the drum' for the professionalism of the instrument industry but has continually improved its many services to the men in the instrument field."

One project Bob has undertaken is to foster an instrument coordinating council in his firm's many varied activities. Instrument groups in NAA's different divisions are being asked to coalesce their instrument problems for the common good of our country's defense effort. Other large aircraft companies are already moving in this direction as their engineers realize the growing need for an interchange of techniques and know-how in this complex science.

A grand-daddy at 49, Bob has an 11-year old boy and a 17-year old girl at home and a married daughter in Trinidad, BWI. An older son went down in the Pacific five years ago in a Navy fighter during training maneuvers. (It was not an NAA ship.)

The ISA is Bob's hobby. He has served on committees and held many offices, both local and national. He contributed to Behar's *Handbook of Measurement and Control,* and has written several magazine articles. He is now working on two textbooks covering flowrate measurement for ICS.

A year ago Bob announced his entry into the consulting business on a part-time basis as an instrumentation and automation engineer—Los Angeles' first consulting engineer to advertise in this field. He hopes now to work for a change in the California State Professional Engineers Act to provide for registration in the field of instrumentation, and to be the first to so register.

Bob finds time to belong to and take an active part in Kiwanis, the local Chamber of Commerce, church and civic work, and in the Boy Scouts. He enjoys choral singing, fishing, charcoal-broiling, and puttering around the yard.

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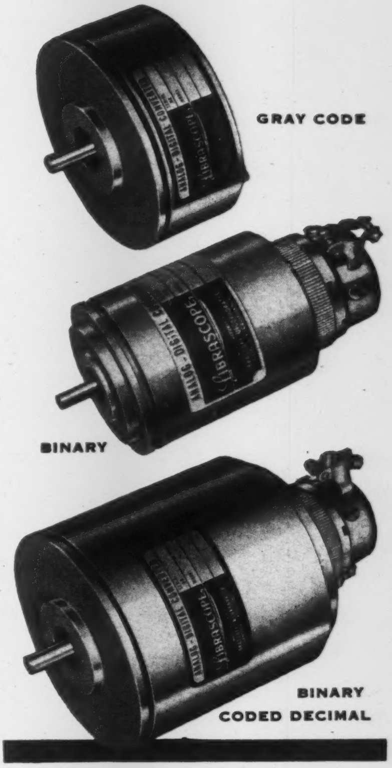

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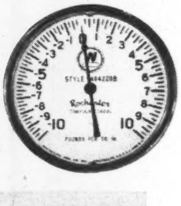

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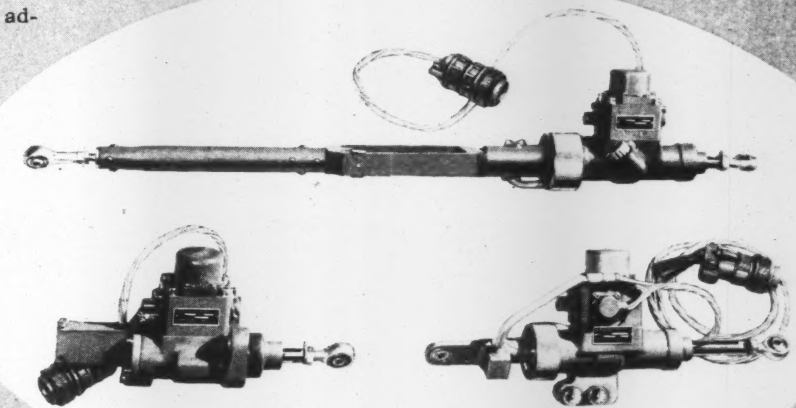

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INSTRUMENTS and AUTOMATION **Editorial**

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—***M. H. Aronson,*** Editor

SCIENTIFIC INSTRUMENTS INDUSTRY

Advance Report; 1954 Census of Manufactures*

During 1954, manufacturers in the Scientific Instruments Industry shipped products valued at $562 million, an increase of 379 percent over 1947, according to preliminary results obtained from the 1954 Census of Manufactures conducted by the Bureau of the Census, Department of Commerce. Average employment in this industry has increased 139 percent since 1947 (when the last Census of Manufactures was taken) to a total of 43.9 thousand employees in 1954. Value added by manufacture in the industry amounted to $342 million in 1954, an increase of 350 percent over 1947. "Value added" is derived by subtracting the cost of materials, etc. from the value of shipments. It avoids, therefore, the duplication in the value of shipments which results from the use of products of some establishments as materials by others and is the best measure available for comparing the relative economic importance of manufacturing among industries and geographic areas. Changes between the two Census years for other key measures of activity for the industry are shown in Table 1. No adjustments have been made for changes in price levels between the two years. All figures in this report are preliminary and, therefore, subject to revision in the final industry bulletin.

The Scientific Instruments Industry represents manufacturing establishments engaged primarily in the manufacture of laboratory, scientific, and engineering instruments such as nautical, navigational, aeronautical, surveying, drafting, mathematical instruments, and instruments for laboratory work and scientific research (except microscopes and telescopes which are in Industry 3831, Optical Instruments and Lenses). Establishments primarily manufacturing surgical, medical, and dental instruments are classified in Group 384, Medical Equipment and Supplies; mechanical measuring and controlling instruments in Industry 3821, Mechanical Measuring Instruments; machinists' precision measuring tools in Industry 3545, Metalworking Machinery Attachments; and instruments for recording electrical quantities and characteristics in Industry 3613, Electrical Measuring Instruments. The industry classification for scientific instruments used in the 1954 Census of Manufactures is based on the *Standard Industrial Classification Manual*, Volume I, Manufacturing Industries, 1945 edition.

The value of shipments, as reported by establishments classified in the Scientific Instruments Industry, consisted not only of products described above as primary to the industry, but also included the value of secondary products (which are primary to other industries). In Tables 1 and 2, the $562 million total value of shipments reported by establishments classified in Industry 3811, Scientific Instruments, consisted of $520 million manufactured products and $42 million miscellaneous receipts for contract work, repair work, sales of scrap, etc. The $520 million product shipments were accounted for by $394 million of scientific instruments, and $126 million of products primary to other industries (e.g. electrical and mechanical measuring instruments, electric motors, aircraft parts). Thus, the industry's shipments of scientific instruments represented 76 percent of its total manufactured product shipments (primary and secondary). This figure describes the "primary product specialization ratio," that is, the extent to which plants classified in an industry "specialize" in making products regarded as primary to the industry. The 1947 primary product specialization ratio for the industry was 81.

The industry's total value of shipments should be clearly distinguished from the total value of primary products of the industry shipped by all producers. The latter figure, appearing in Table 3, indicates that $620 million value of scientific instruments were shipped by all producers. Of this total, 64 percent was shipped by plants classified in Industry 3811, while the remainder was shipped as secondary products by plants classified in other industries. The figure 64 percent is known as the "coverage ratio," that is, it measures the extent to which all shipments of primary products of an industry are "covered" by plants classified in that industry, as distinguished from secondary producers elsewhere. In 1947, the coverage ratio for this industry was 84. This significant decrease in coverage ratios between the two years is due to the increasing production of aircraft flight instruments by establishments primarily producing ordnance equipment. Such establishments in 1954 accounted for about one-sixth of all of the scientific instruments shipped.

Relatively low coverage and specialization ratios are characteristic of the several instruments industries. There tends to be considerable overlap among scientific instruments, mechanical measuring instruments, electrical measuring instruments and fire control equipment as well as a characteristic of establishments in this group of industries to produce secondary products such as motors, optical instruments, fire control equipment and other products which require similar production facilities,

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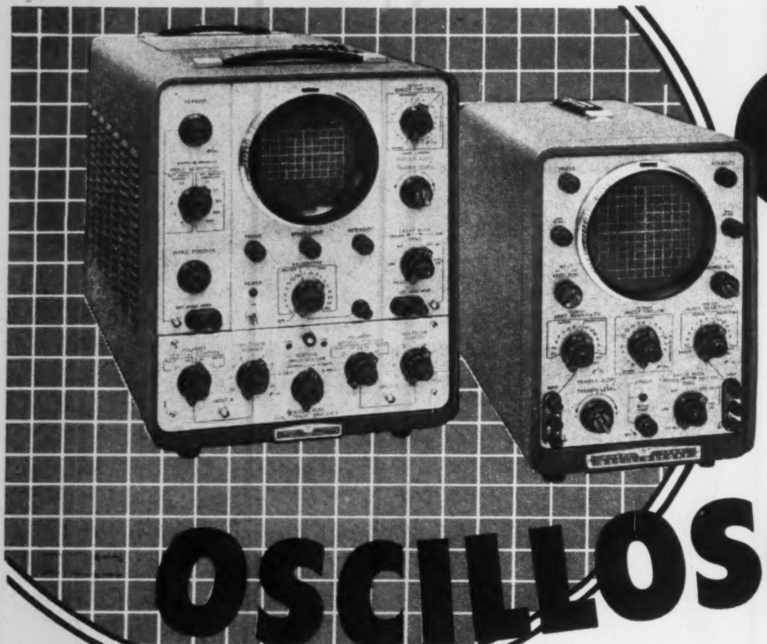
* Series MC-38-1.1, April, 1956, U.S. Department of Commerce; available from Bureau of Census, Washington 25, D. C., and U.S. Dept. of Commerce Field Offices.



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materials, etc. Since the classification of an establishment is determined by its principal products *in a given year*, a relatively small shift in the emphasis on a given line of production (e.g., scientific instruments to electrical measuring instruments, or vice versa), may change the classification of the establishment and result in sizeable variations in the general statistics such as employment, cost of materials, etc. for both industries affected. Such developments are not wholly valid measures of changes in activity of the industries but reflect important differences in the industry classification of the same establishment from one Census year to the next. A somewhat more accurate picture of the changes in activity in the instruments industry is obtained by aggregating the three instruments industries. The product data on instruments are, of course, not affected by these shifts in industry classification of individual establishments.

The general statistics (employment, payrolls, cost of materials, value of shipments, etc.) are reported for each establishment as a whole. Aggregates of such data for an industry reflect not only the primary activities of the establishments in that industry, but also their activities in the manufacture of secondary products and receipts for their other activities (contract work on materials owned by others, repair work, etc.). This fact should be taken into account in comparing industry statistics (Tables 1 and 2) with product statistics (Table 3) which show the shipments by all producers of the primary products of the industry.

More detailed figures for this industry will appear later in the Census Bulletin, MC-38A, "Instruments; Surgical, Dental, and Ophthalmic Goods," which will be published and offered for sale at a later date by the Superintendent

Table 1.—General Statistics for the Scientific Instruments Industry in the United States (Standard Industrial Classification Code 3811)

Item	Unit of measure	1954	1947	Percent change 1947-1954
Establishments	Number	367	215	+71
All employees:				
Number	Thousands	43.9	18.4	+139
Payroll	Million dollars	210.5	56.0	+276
Production workers:				
Number	Thousands	29.7	13.5	+120
Man-hours	Millions	61.5	27.2	+126
Wages	Million dollars	129.4	37.7	+243
Value added by manufacture[1]	do	341.6	75.9	+350
Cost of materials, fuel, electricity, and contract work[2]	do	220.5	41.4	+433
Value of shipments[3]	do	562.1	117.3	+379
Capital expenditures, new	do	8.6	4.5	+91

[1] Value of shipments less cost of materials, supplies, fuel, electric energy, and contract work.

[2] Excludes cost of products bought and resold in the same condition.

[3] Includes not only (a) their value of products "primary" to the industry, but also (b) their value of "secondary" products, which are primary to other industries, and (c) their "miscellaneous receipts" for repair work, sales of scrap, installation of own products, etc. Excludes sales of products bought and resold in the same condition.

Table 2.—General Statistics for the Scientific Instruments Industry by Region

	1954										1947	
		All employees		Production workers								
Region	Establishments, number	Number	Payroll ($1,000)	Number	Man-hours (1,000)	Wages ($1,000)	Value added by manufacture[2] ($1,000)	Cost of materials etc.[3] ($1,000)	Value of shipments[4] ($1,000)	Capital expenditures, new ($1,000)	All employees, number	Value added by manufacture[2] ($1,000)
U. S. total[5]	367	43,938	210,530	29,707	61,472	129,360	341,559	220,532	562,119	8,599	18,419	75,922
New England	36	3,559	14,941	2,423	4,965	8,677	26,785	11,233	38,048	1,119	585	2,766
Middle Atlantic	113	19,019	96,412	12,856	26,343	59,770	138,156	100,508	238,664	3,981	12,056	49,076
East North Central	68	8,402	40,436	5,809	12,759	26,417	71,671	61,168	132,840	1,216	2,823	11,972
West North Central	15	6,947	31,306	4,269	8,751	17,233	57,961	24,319	82,281	812	177	801
South	51	2,563	11,172	1,755	3,580	6,698	17,769	9,361	27,131	598	1,327	5,224
Mountain	9	72	336	62	122	270	508	482	991	16	......	......
Pacific	75	3,374	15,924	2,529	4,949	10,292	28,705	13,457	42,163	853	1,451	6,083

[2] Value of shipments less cost of materials, supplies, fuel, electric energy, and contract work.

[3] Includes cost of materials and contract work; excludes cost of products bought and resold in the same condition.

[4] Includes not only (a) their value of products "primary" to the industry, but also (b) their value of "secondary" products, which are primary to other industries, and (c) their "miscellaneous receipts" for repair work, sales of scrap, installation of own products, etc. Excludes sales of products bought and resold in the same condition.

[5] Sum of regional figures may not equal U. S. total, due to independent rounding.

EDITORIAL—CONTINUED

of Documents, U. S. Government Printing Office. Similar advance reports and final bulletins will be issued for other industries during the coming months. A summary of preliminary United States totals for each manufacturing industry and totals for each State will also be issued in the next few months. Advance reports for individual States will appear in May and June of 1956, to be followed later in the year by the detailed State bulletins. (Order blanks which list these reports and bulletins and their prices may be obtained from local U. S. Department of Commerce Field Offices or by writing to: Bureau of the Census, Washington 25, D. C.)

The 1954 Census of Manufactures is the twenty-sixth such census of the United States since 1809. For 1954, it was conducted jointly with the Censuses of Business (Wholesale, Retail, and Services) and Mineral Industries, covering continental United States, Alaska, and Hawaii. Present legislation provides for a Census of Manufactures every five years, with the next one scheduled to cover 1958. In addition, the law authorizes annual sample surveys to be conducted in interim years.

Table 3.—Value of Scientific Instruments Shipped by all Producers in the United States

(Includes products reported both by establishment classified in the Scientific Instruments Industry and by establishments making these items as "secondary" products in other industries)

Product code	Product	Total value of shipments including interplant transfers ($1,000)	
		1954	1947
3811	Scientific instruments, total	[1]620,427	*107,4[illegible]5
38111	Aircraft and nautical instruments, except aircraft engine instruments	515,834	(NA)
3811111	Aircraft flight instruments and automatic pilots	378,897	20,4[illegible]8
3811198	Other aircraft, nautical, and navigational instruments	136,935	([illegible])
3811211	Surveying and drafting instruments and apparatus	17,998	*19,6[illegible]8
3811311	Other scientific instruments and laboratory apparatus (excluding electrical quantity measuring instruments, and industrial process instruments).	86,594	[2]67,3[illegible]9

*Revised.

[1] Of this total 64 percent was shipped by plants classified in the Scientific Instruments Industry; the remainder was shipped as secondary products by plants classified in other industries.

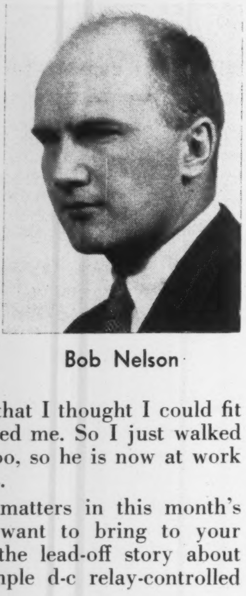
[2] Data for other aircraft, nautical and navigational instruments for 1947 are included with "Other Scientific Instruments and Laboratory Apparatus" (code 381311).

NA Not available.

Dear D.R.*:

Here it is—your May issue, and another month has passed (too quickly). But nothing stays the pace of time; all we mortals can do is try to keep up with the times—one of the major objects of this issue.

Before telling you about it, however, we want you to meet the newest member of your staff of *I&A*—Bob Nelson, Associate Editor. Bob has broad experience in technical and industrial work. He has an M.S. degree in Industrial Administration from the Carnegie Institute of Technology; he has been an instructor in the fields of power generation and electrical systems; and he has worked in the fields of public relations and the design of industrial products. He came to us because, in his own words, "I wanted to get into publication and educational work, and looked over all the publications that I thought I could fit into. Yours, interested and excited me. So I just walked in cold." Well, Bob excited us too, so he is now at work as one of your Associate Editors.



Bob Nelson

There are several important matters in this month's feature-article section that we want to bring to your attention. First, we think that the lead-off story about the growth of CTC from a simple d-c relay-controlled track circuit to a centralized transport control system is a dramatic story that tells a lot about the evolution of automation systems.

Secondly, you will find many practical details in Robert Marmorstone's article on "Process Data Logging Systems" (with an assist by Arthur Freilich) that have not been brought out clearly in the past—particularly, how multiplication, square-root extraction, integration, time compensation, and analog-to-digital conversion are worked into the system.

And speaking of analog-to-digital conversion, perhaps you better turn *right now* to the article "Analog-to-Digital Conversion" by Klein, Williams, and Morgan (part 8 of their tremendous series)—because this is something you just can't afford to miss for any reason whatsoever. A lot has been written on this subject, but nothing that we know of comes close to the thoroughness and clarity of this article.

Terminology is always an important subject—and there seems to be a flurry of activity in the valve field. So this month we bring you control valve terminologies suggested both by the Fluid Controls Institute and by W. D. Washburn and Russell Milham in their ASME paper 55-A-91. There are several important points of difference: we like the FCI term "Actuator" better than the Washburn-Milham term "Motor" for the valve operating mechanism. And we like the Washburn-Milham term "Plug" better than the FCI term "Closure Member" for the inner valve. See which you prefer—and let us know what you think.

We are running out of space on this page—so we will close with a personal greeting. Hope this finds you well and happy this month.

Cordially,

Milt and the Editors

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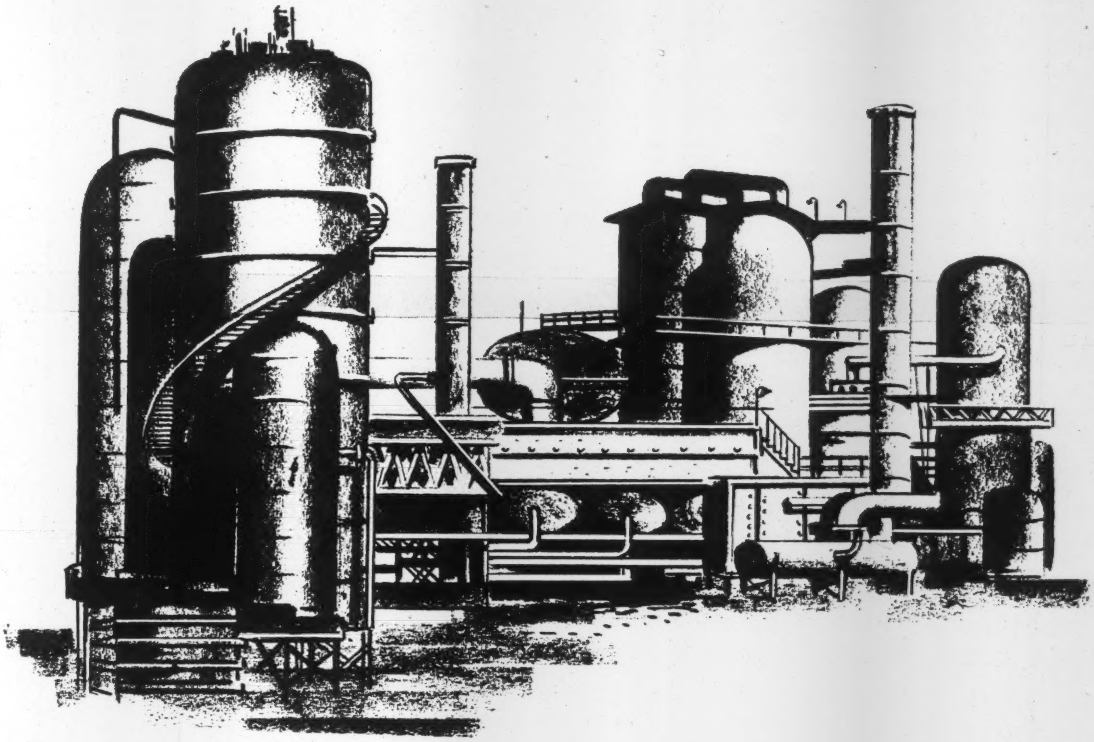
*Dear Reader



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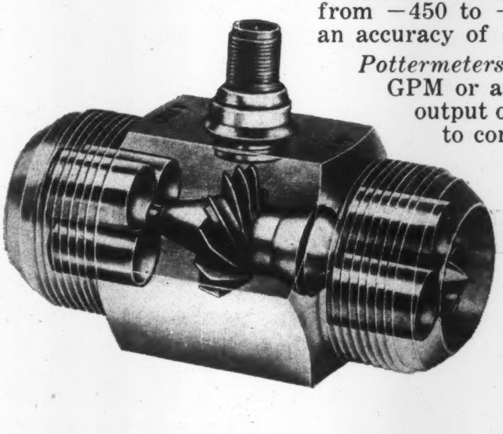

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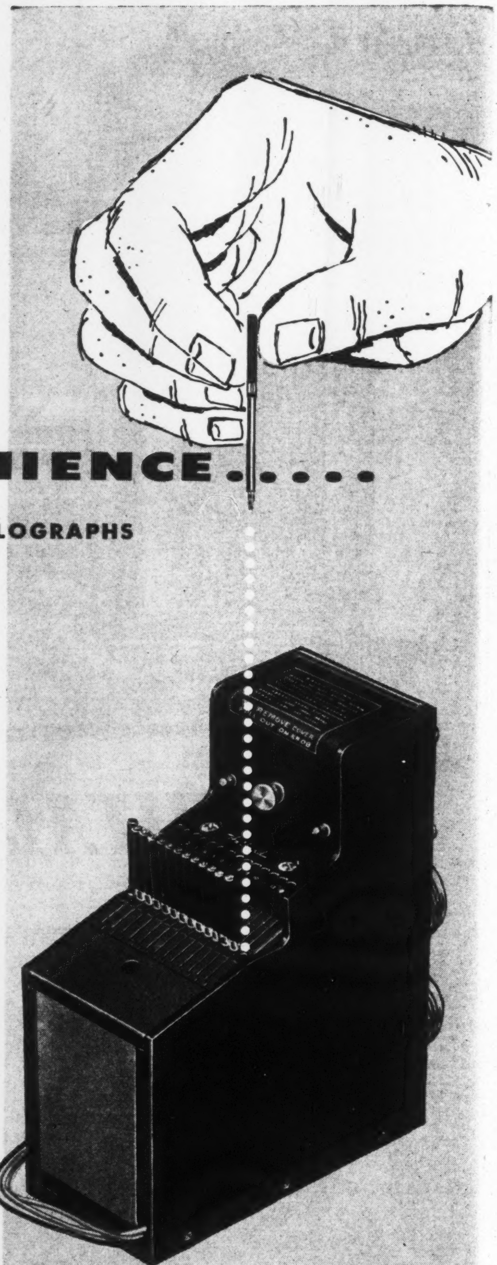

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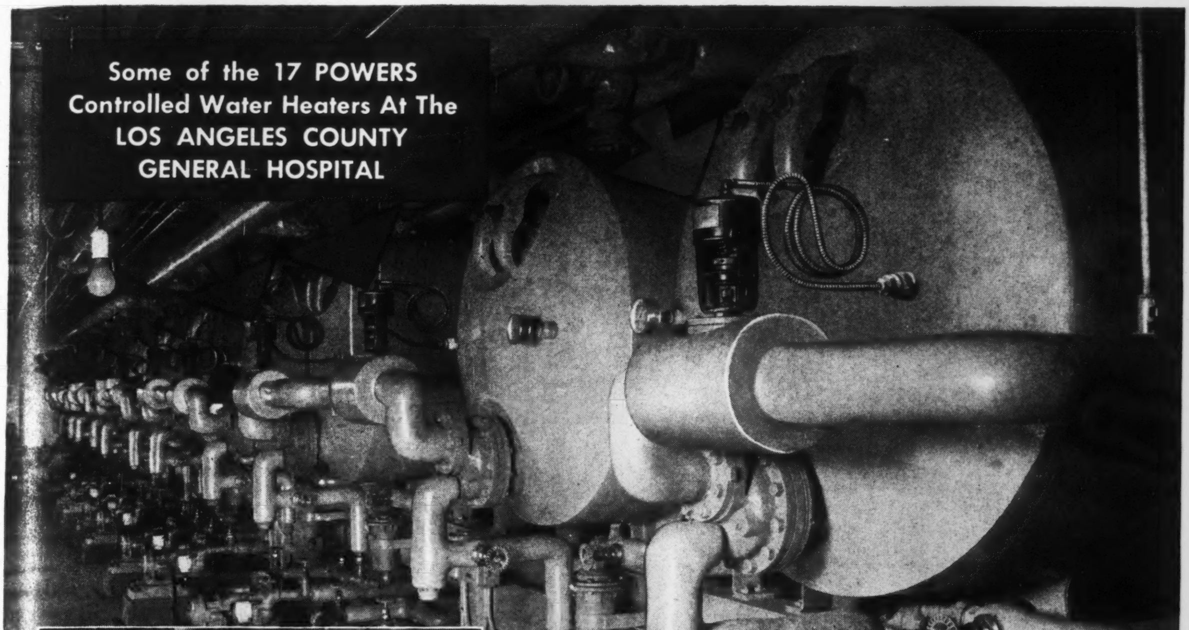
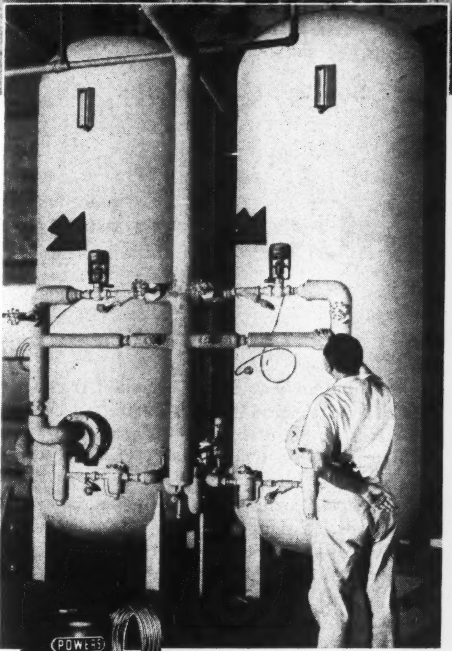


Some of the 17 POWERS Controlled Water Heaters At The LOS ANGELES COUNTY GENERAL HOSPITAL



In 1933 Howe Bros., Contractors, installed 15 Powers Regulators here. All are still in operation, only 11 are shown in photo above.

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are still giving dependable control"

Reports Mr. Louis J. Koch, Senior Master Mechanic

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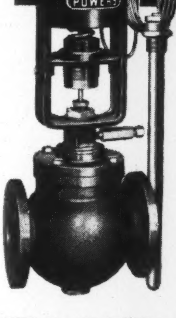
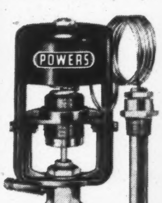


Above: 1955 installation of Powers Controlled Water Heaters in Contagious Disease building. Contractor: E. Willardson Company.

(c48)



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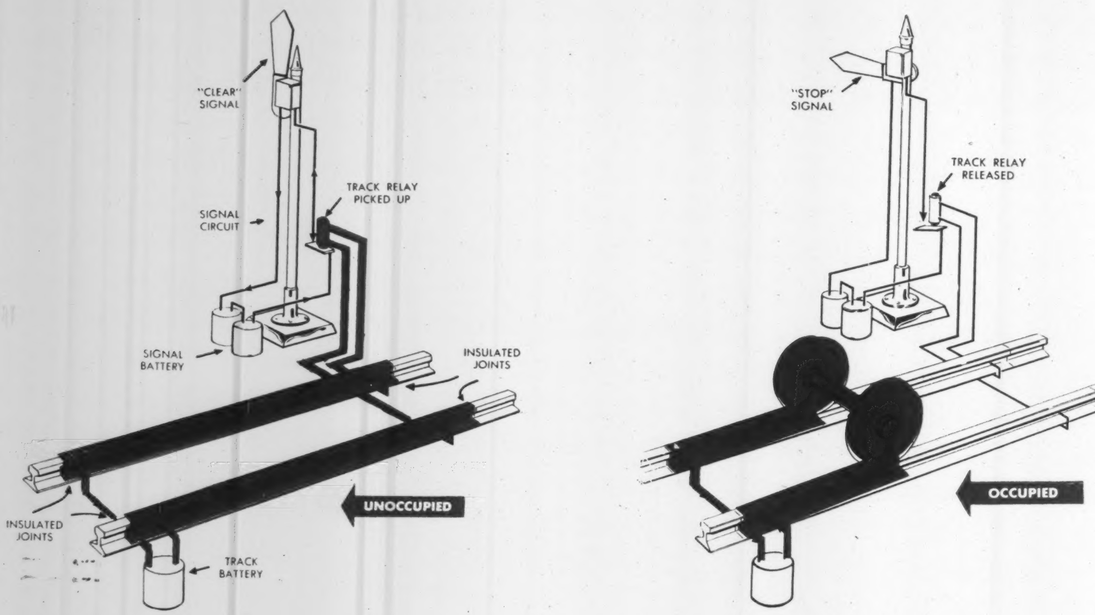

Fig. 1. Basic d-c track circuit, invented in 1872 and still in general use, comprises a block (1½ miles of track) between insulated joints. Track battery is at exit end of block; signal at entrance end. Presence or absence of train on block is thus indicated by signal at the entrance end of the block, as shown.

CTC—Centralized

Automation as a word evokes an image of complex electronic computer-controlled processes. This image is not without value as a projection of the future. In practice, however, the specific control problem usually resolves itself into the application of familiar control devices in relatively simple unit operations.

One characteristic of modern automatic control is its rapid expansion into every phase of industry and finance, an expansion firmly based on the economic benefits obtainable via faster operations and remote control. The story of how one of the earliest control systems put to work in our country has evolved into a complete automation system for general industrial application is a dramatic story of that tells much about the development of the field of automation.

The relay is the hero of this, as of so many other control stories, and the relay will be the starting point of this story, which will show how a time-proved system has evolved from a wayside track signaling device to a centralized transport control (CTC) system for pipelines, hoists, and other industrial operations. The story starts with the railroad industry in the year 1872 and the invention of the track circuit, a d-c circuit that indicated the presence or absence of one train on one section (block) of track via wayside signaling stations.

The next basic advance was the use of a 100-cps a-c signal on the track, which signal was picked up inductively to energize signals within the cab of the train.

The next development was use of a coded track signal instead of the d-c track signal, which permitted the monitoring and control of many functions, in contrast to the single function of the d-c track circuit (presence or absence of a train on the block).

Next, and of recent origin, came the remote control of all wayside stations and all traffic via a CTC (central traffic—or transport—control) center, which now permits control of an entire railway net from one central location.

The latest chapter in this story is the extension of this CTC system to the control of pipelines, aircraft, and other industrial operations.

Chapter 1—The D-C Track Circuit

Although railway signaling was developed mainly to provide safety, the economic advantages were not overlooked by early railroad managers. Block signaling, using the closed-circuit track principle, was invented in 1872 and has not changed in principle.

The principle is shown in Fig. 1. Presence of a train on any section or block of rail (that is, the rail between successive signaling stations) prevents the d-c signal from the *track battery* from reaching the *track relay*, which then displays a "stop" signal at the entrance to the block.

Insulated sections of rail joint prevent the track-circuit current from flowing from one block into the next. Thus

Transport Control

Union Switch & Signal, Division of Westinghouse Air Brake Company, celebrates its 75th anniversary this year—by embarking on a program designed to carry CTC (centralized transport control) into all fields where their time-proved railroad control systems can be applied. This "transport" includes the transport of oil and gas in pipelines, the transport of aircraft in airlines, the transport of elevators in TV towers, etc. The transport control system shows how automation systems evolve from time-proved components.

MILTON H. ARONSON*
PAUL BOSSART**
HOWARD A. THOMPSON**

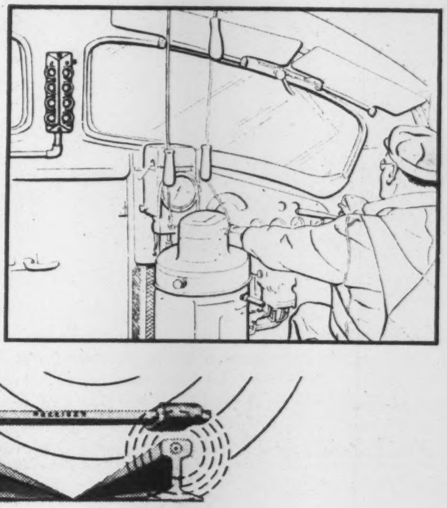

Fig. 2. Two receiver coils, located on the locomotive and near the rails, pick up the a-c signals (superimposed on the d-c signal whenever the train is on a block) and relay them into the cab.

each block of track is a separate track circuit. On modern systems the "block" is about $1\frac{1}{2}$ miles in length, the smallest distance in which a heavy train traveling at fast speed can be stopped.

A development that occurred very soon after the use of the first d-c track circuit was the transmitting of the block condition (track signal) back to an adjacent block via line wires. This was called the "automatic block" because data about block conditions were extended for one or more blocks.

The basic track circuit must be completely reliable and fail-safe. Any failure of the track circuit which may be caused by loss of power, a broken rail, a broken wire, a switch out of alignment, or a short circuit will de-energize the track relay, thus causing it to release and set the wayside signal at "stop." The track circuit, like all vital circuits in railway signaling, is designed to operate on this "fail-safe" principle.

Note that this basic track circuit is for control of wayside signals. Note also that it is a d-c system, and that a signaling battery, a track battery, a track relay, and a signaling device are used at each wayside signaling point. The track relay is energized by the track battery at the remote end of the block to indicate whether the block of rail is occupied or not.

The next step is obviously the transmission of the track signal into the cab, for use as a monitoring or a control signal. This historically important development started in 1916, when Union Switch & Signal introduced the first application of electronics outside the field of communication.

Chapter 2—Cab Signaling

The track signal is coupled into the cab of the locomotive by induction. An a-c signal (100-cps) from a source located at the wayside signaling point is applied to the rails (only when the train is on the block). The 100-cps signal is interrupted 180, 120, or 75 times per minute (depending on traffic conditions) by a code transmitter, and is inductively picked up by a coil located on the locomotive (ahead of the front axle and within 6 inches of the rail). The signal is amplified on the train and used to operate signals inside the cab (Fig. 2).

The train-carried equipment includes a *receiver,* which picks up impulses by induction from the current in the rails and transmits them to the control equipment box; a *control equipment box,* featuring plug-in equipment which filters, amplifies, and decodes the impulses from the receiver for control of the cab signal and whistle; a *cab signal,* which is continuously controlled to indicate track conditions ahead by means of color-light aspects; a *whistle* that sounds a warning whenever the cab signal changes to a more restrictive indication; and an *ac-*

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* Instruments and Automation
** Union Switch & Signal Division of Westinghouse Air Brake Company

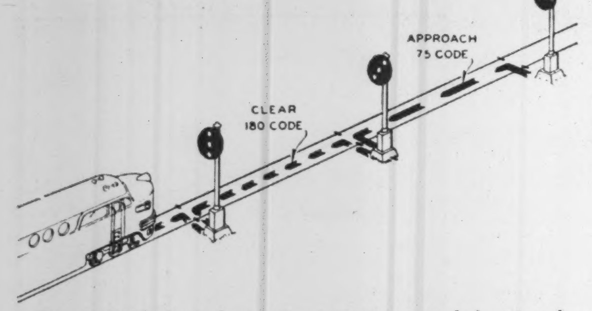


Fig. 3. Coded track circuits use interrupted d-c signals. Code frequencies of 180, 120 and 75 pulses per minute are in common use. In situation shown here, the 180 code is used to indicate that next two blocks are clear; the 75 code indicates that its block is clear but that next one is not. The 120 code is used when it is desired to extend the signaling to 3 blocks rather than the 2 shown.

knowledging switch which provides means for silencing the warning whistle. Details of this equipment will be given in a following discussion on coded a-c signals.

In actual service, the "signal-that-rides-in-the-cab" is in constant view of the engineman. As it is continuously controlled to reflect track and traffic conditions ahead, situations permitting an increase in speed are indicated instantly by the cab signal. Thus the engineman can safely take full advantage of the power and speed of modern equipment.

Chapter 3—The Coded Track Circuit

A basic limitation of the d-c track circuit is its ability to indicate only one variable, the presence or absence of a train on one block of track (except when line wire is used on the "automatic block" as mentioned previously). This limitation was overcome by interrupting the d-c signal at different rates, producing a coded signal whose code could be changed to indicate the condition of more than one variable. This development occurred about 1925.

Standard code frequencies of 180, 120 and 75 pulses per minute are used to indicate clear, approach-medium, and approach indications (Fig. 3). Stop indications are produced by the absence of current or the presence of non-coded current in the track circuits. In Fig. 3, the 180 code indicates that there is no train on the next two blocks; the 75 code indicates that there is a train on the next block and hence the train being signalled can only approach but not enter the next block; the absence of any code indicates that there is an obstruction on the same block as the train being signalled, which must stop at once or proceed slowly within range of vision. Note that 3 conditions are monitored by the use of two codes —180 and 75. The 120 code is used when it is desired to extend the signaling to 3 adjacent blocks.

In addition to the basic frequency code described, which is obtained simply by interrupting the track battery at a desired rate, other coding systems have been investigated and can be used as desired. These systems include: (1) polar code, in which the polarity of impulse changes, (2) time codes, in which the length of the pulse can be varied, and (3) count codes, in which a different number of pulses occurs in a given interval. The basic frequency code, however, is most popular in the American railroad industry.

Fig. 4 shows the equipment required for a coded track circuit using only 180 code and 75 code; Fig. 5 shows a circuit diagram for a coded track circuit employing the 180, 120 and 75 code.

In addition to the basic advantage of a coded track circuit over the d-c track circuit, which is ability to

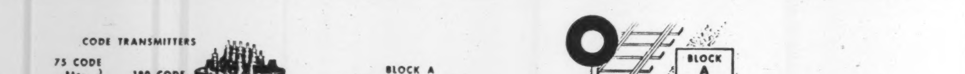


Fig. 4. Equipment required for a coded track circuit using 180 code and 75 code. Approach control relay selects the appropriate code as called for by conditions on block A. Code-following track relay at other end of block transfers signal to decoding units.

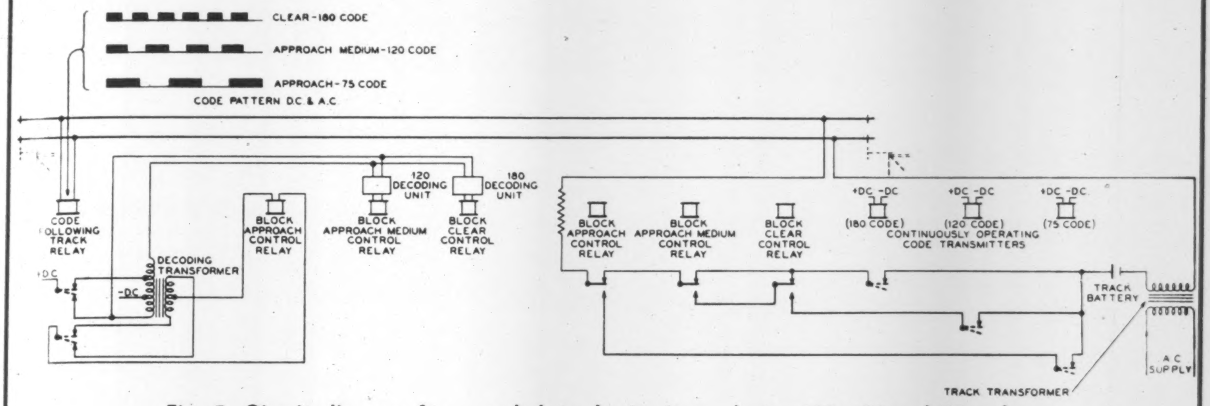
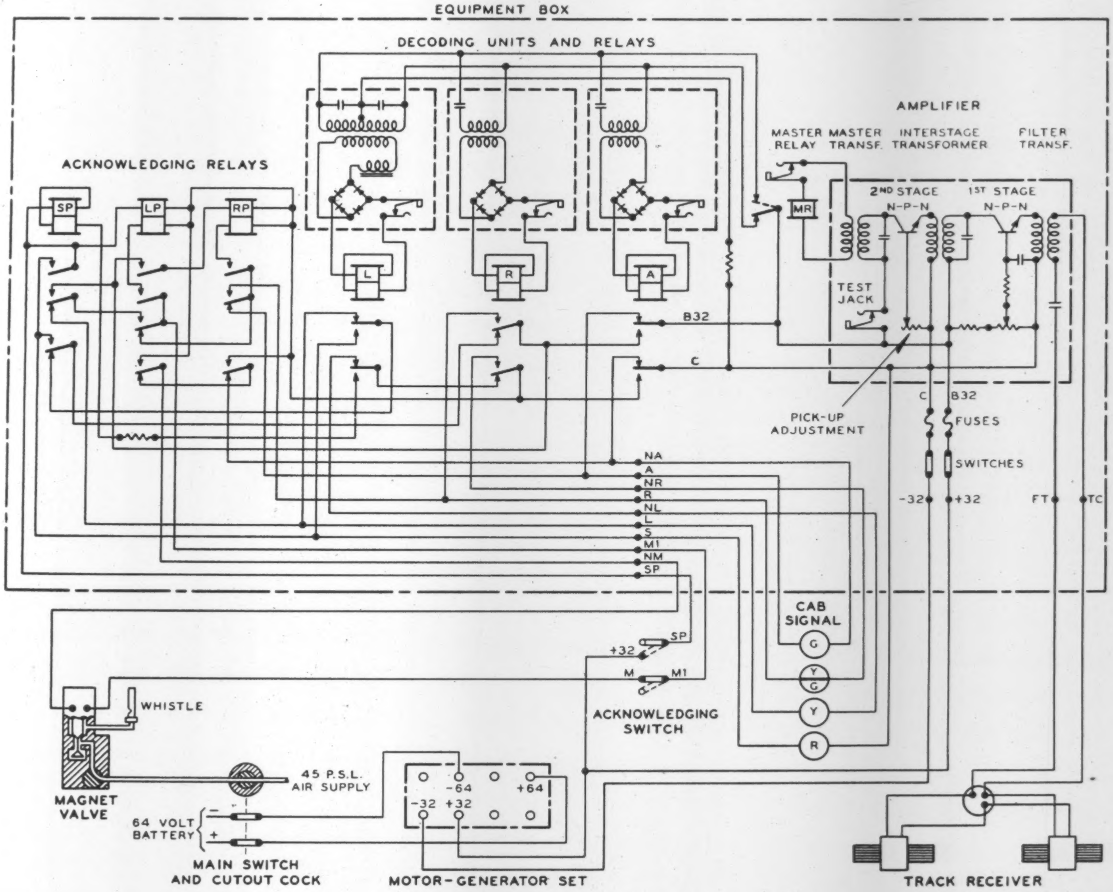

CLEAR-180 CODE
APPROACH MEDIUM-120 CODE
APPROACH-75 CODE
CODE PATTERN DC & A.C
CODE FOLLOWING TRACK RELAY
+DC
-DC
DECODING TRANSFORMER
BLOCK APPROACH CONTROL RELAY
120 DECODING UNIT
180 DECODING UNIT
BLOCK APPROACH MEDIUM CONTROL RELAY
BLOCK CLEAR CONTROL RELAY
BLOCK APPROACH CONTROL RELAY
BLOCK APPROACH MEDIUM CONTROL RELAY
BLOCK CLEAR CONTROL RELAY
+DC -DC
(180 CODE)
+DC -DC
(120 CODE)
+DC -DC
(75 CODE)
CONTINUOUSLY OPERATING CODE TRANSMITTERS
TRACK BATTERY
A.C SUPPLY
TRACK TRANSFORMER

Fig. 5. Circuit diagram for a coded track circuit employing 180, 120 and 75 code.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MR
2ND STAGE N-P-N
1ST STAGE N-P-N
TEST JACK
B32
C
PICK-UP ADJUSTMENT
C
B32
FUSES
SWITCHES
-32
+32
FT
TC
NA
A
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R
NL
L
S
M1
NM
SP
CAB SIGNAL
G
Y/G
Y
R
+32
SP
M
M1
ACKNOWLEDGING SWITCH
WHISTLE
MAGNET VALVE
45 P.S.L. AIR SUPPLY
64 VOLT BATTERY
-
+
MAIN SWITCH AND CUTOUT COCK
-64
+64
-32
+32
MOTOR-GENERATOR SET
TRACK RECEIVER

Fig. 6. Train-carried equipment for detecting the signals in the track circuit. The two pickup coils (lower right) detect the signal in the track circuit. The signal is amplified in the transistor amplifier and then decoded to operate the appropriate cab signal or whistle alarm. Relays are wired so engineman must acknowledge warnings.

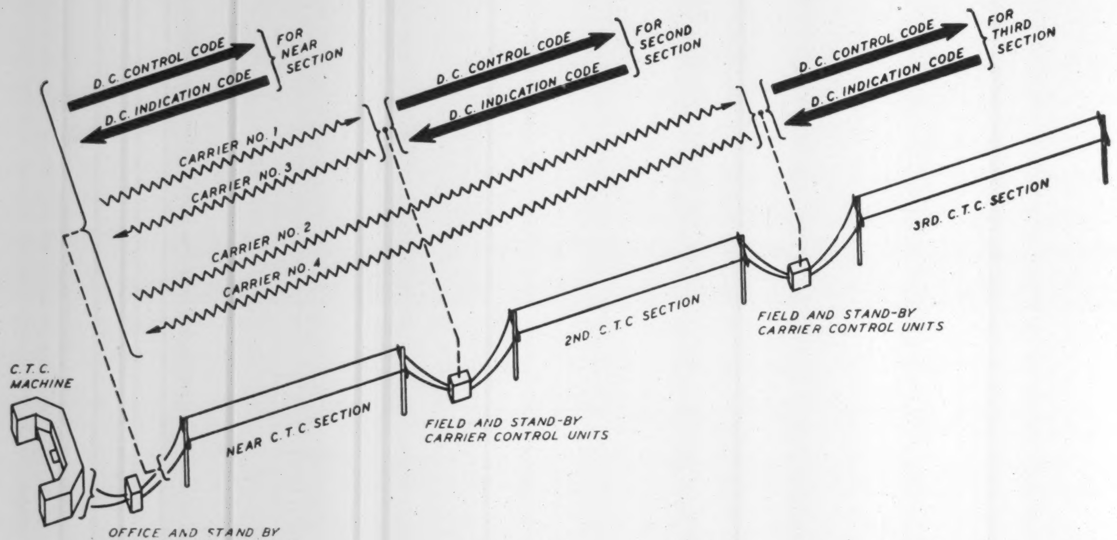
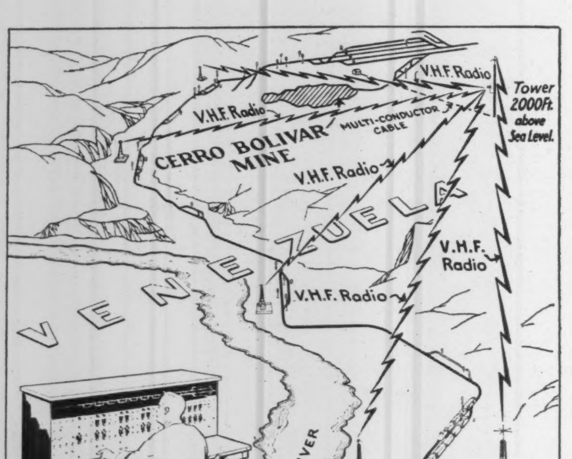

D. C. CONTROL CODE
D. C. INDICATION CODE
FOR NEAR SECTION
D. C. CONTROL CODE
D. C. INDICATION CODE
FOR SECOND SECTION
D. C. CONTROL CODE
D. C. INDICATION CODE
FOR THIRD SECTION
CARRIER NO. 1
CARRIER NO. 3
CARRIER NO. 2
CARRIER NO. 4
3RD. C. T. C. SECTION
FIELD AND STAND-BY CARRIER CONTROL UNITS
2ND. C. T. C SECTION
C. T. C. MACHINE
FIELD AND STAND-BY CARRIER CONTROL UNITS
NEAR C. T. C SECTION
OFFICE AND STAND BY CARRIER CONTROL UNITS

Fig. 7. Use of line wires to carry the track circuit signal back to the centralized traffic control (CTC) center, and control signals from the CTC center to the field stations. Separate carriers are used for each block.


V.H.F. Radio
Tower 2000Ft. above Sea Level.
V.H.F. Radio
MULTI-CONDUCTOR CABLE
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V.H.F. Radio
VENEZUELA
V.H.F. Radio
V.H.F. Radio
CARONI RIVER
Begin C.T.C.
MULTI-CONDUCTOR CABLE
100 Ft. above Sea Level.
PUERTO ORDAZ
TO OCEAN
ORINOCO RIVER

Fig. 8. Centralized traffic control system for railroad serving U. S. Steel's Cerro Bolivar Mine in Venezuela uses VHF (30-50 Mc and 80-90 Mc) links between CTC center and each block control unit.

monitor more than one variable (conditions on two or more blocks—without use of line wires), the coded circuit has other advantages—greater shunting sensitivity, increased length of track circuits, better broken-rail protection, and greater immunity to foreign currents.

Coded A-C Signals

When the locomotive is equipped with cab signals, it is necessary to transmit the track signal into the cab. This is done by superimposing an a-c signal on the d-c track signal as long as the train is on the block. The a-c signals are detected inductively, as explained previously, and are turned off automatically when the train leaves the block.

Frequencies of 60, 80, and 100 cps can be used for this purpose. The minimum value of this a-c current which flows through the axles when the train is at the entering end of track circuit usually is of the order of 2.0 amperes where electric propulsion territory is involved and 0.7 ampere elsewhere.

This use of coded a-c signals in the track circuit permits inductive detection of the signal in the cab. Fig. 6 shows the equipment carried on the locomotive. Voltages of the same frequency and code as the rail current are induced in receiver coils carried on the locomotive. These voltages, after being amplified in a 2-stage transistor amplifier, are used to operate a code-following-type relay called the "master" relay. This relay, in turn, governs decoding units that are selectively responsive to the code rate at which the master relay is operated. The associated decoding relays control the cab signals and the warning whistle valve magnet. The acknowledging relays are also controlled by the decoding relays in such a manner as to require the enginemen to "acknowledge" a change in the cab signal indication when the change is to a more restrictive indication. The pickup coils are indicated by the "track receiver" at bottom right in Fig. 6.

The first installation of continuous cab signaling was placed in service July 11, 1923 on the Pennsylvania Railroad between Lewistown and Sunbury, Pa., Today there are approximately 5,2000 motive power units and 11,000 miles of track in the United States equipped with cab signaling. The largest user of this system is the Pennsylvania Railroad, on whose lines one may ride between New York, Philadelphia, Washington, Pittsburgh and Indianapolis under the protection of cab signaling all of the way. The Union Pacific Railroad is the second largest

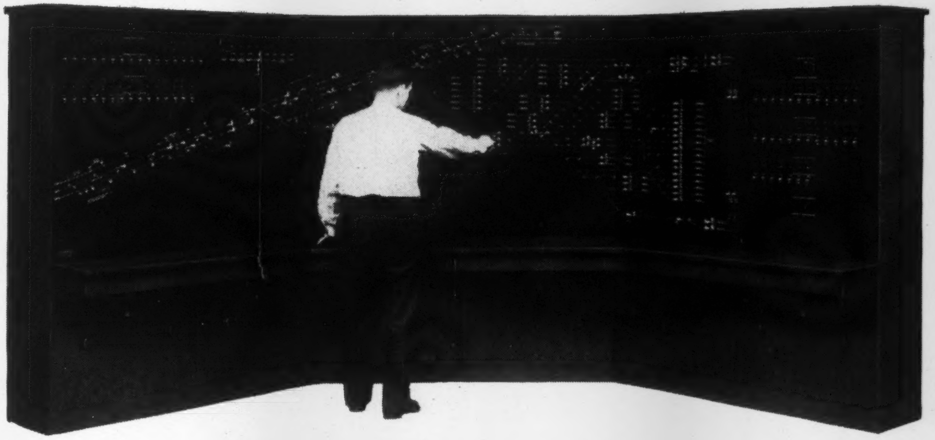

Fig. 9. Control panel by which an operator can select best route through interlocking system. Equipment automatically selects the best route when operator pushes buttons at extremities of desired route.

user with approximately 2,100 miles of main line track and 330 locomotives so equipped.

Chapter 4—Controlling the System

The use of code in the track circuit permitted the handling of more than one variable, and the use of inductive technique permitted the signal to be detected by the locomotive. The next step was to transmit the signals back to the dispatching center.

This opened a new era in traffic control because knowledge of all conditions at the central dispatching point opened the way to remote control of the entire system from the center, making possible centralized traffic control—CTC.

The condition of all important variables within one block of traffic is indicated by the signal in the d-c or coded track circuit. This signal must be relayed to the dispatching center for centralized traffic control—by line wires, r-f transmissions, microwave circuits, or any transmission system that meets the needs of the particular terrain.

Fig. 7 shows how one pair of line wires can be used to control many CTC sections (usually 50 miles of traffic in each section) from the CTC center. This is done by using separate carrier frequencies for each field unit. Carrier No. 1 is used to carry control signals from the CTC unit to field unit 1, which translates this data into normal d-c control code for its CTC section. Signals indicating conditions in this section are retransmitted back to the CTC unit by carrier No. 3. Similarly, carriers 2 and 4 are used for remote control of the next CTC section.

The use of controlling signals from the central control point permits remote control of all types of traffic systems, single or multiple track, from a central location. This in turn permits optimum use of all facilities.

Fig. 8 shows a centralized traffic control system installed on a railroad serving U. S. Steel's Cerro Bolivar line in Venezuela, S. A., using microwave links.

Fig. 9 shows a control panel by which an operator can control all switches and signals within a selective route simply by pushing two buttons, one each at the extremities of a desired route. Where more than one route through an interlocking are available, the equipment automatically selects the best route. The routes are self restoring. The operator can rapidly establish routes for train movements through heavy-traffic territory.

Identification

An important step toward complete railroad automation was the introduction, by Union Switch & Signal, of the "Identra" *system for train identification (Fig. 10). With this system, trains register their identity as they pass identification points.

For example, the "Identra" system in Fig. 11 automatically positions the switches and clears the signals at 2 and 4 as trains A and B pass wayside identification units at 1 and 3. The information is also used to identify the trains on the CTC machine and at the station. With this identification system, which operates at any train speed, a block is no longer merely occupied; it is occupied by a passenger express, local freight, etc.

Visual indications of the position and identification of every train in the territory are displayed on the CTC machine by means of track-model lights. Progress of the trains is continuously evident, so that a meet or pass can be arranged when the location of trains indicates the obvious point for such a move, whereupon switches

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*Trademark

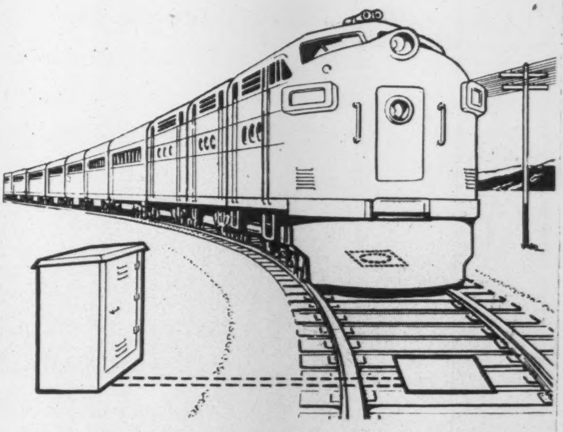


Fig. 10. "Identra" system for train identification uses an inert identification coil on the locomotive, which couples inductively with a wayside identification coil, registering the class of train.

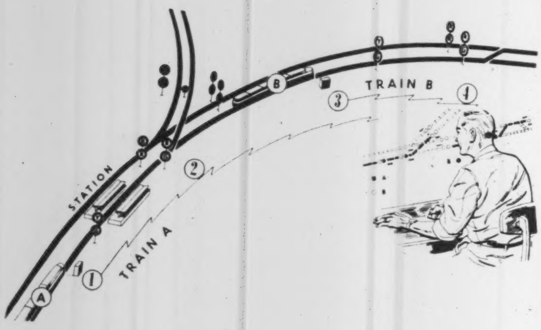


Fig. 11. This "Identra" system automatically positions the switches and clears the signals at 2 and 4 as trains A and B pass wayside identification units at 1 and 3. The information is also used to identify the trains on the CTC control machine and at the station.

Fig. 12. Pipeline dispatcher controlling operation of remote booster pumps from CTC console.

and signals are rapidly arranged by simple lever manipulation on the control machine. When normal movements are disrupted, trains which can proceed are advanced instead of waiting at pre-scheduled meeting and passing points.

CTC saves numerous stops and delays, eliminates congestion, and surrounds the movement of trains with safety. This results in a smoothly functioning railroad, operating with greater efficiency, increased train load, and shortened schedules.

Chapter 5—Extension of Centralized Transport Control to Pipelines and Other Industrial Operations

Pipeline Control

The same techniques for control of railroad networks from a central point can be applied directly to the operation of a number of pumping stations from a central dispatching office. Fig. 12 shows a pipeline dispatcher controlling the operation of remote booster pumps.

Data about which pumps are on the line, which valves are open, temperatures and pressures at selected points, etc., are relayed to this CTC center via coded pulses. Indicating lamps show operating conditions. Also indicated can be the location of radioactive tracers, the presence of leaks, dangerous atmospheric conditions, or any condition being monitored.

The opening of valves or the starting of pumps is done simply by flipping a switch on the control console. The switch selects the proper control code and sends it over the communication system chosen, which may be a line wire, an r-f telemetering system, etc. Lights on the console indicate exactly what is happening at the remote station.

Fig. 13 shows the CTC board for the Badger Pipeline, which is shown in Fig. 14.

A time code system is used to perform the many remote-control functions, the code operating a chain of relays. Fig. 15 shows a typical control console for transmitting the desired coded signals.

Air Traffic Control

An automatic system for air traffic control on a nationwide scale requires that data for numerous remotely located aircraft be supplied to computers on a continuous basis and that the computer output be

Fig. 13. CTC board for remote control of the Badger Pipeline, which extends from Wisconsin to Illinois, as shown in Fig. 14.

promptly available to individuals who may also be remotely located. The time for this entire process must be short enough that air traffic controllers concerned with a predicted confliction between aircraft can be aware of the difficulty in time to re-assign airways or altitudes to avoid an accident.

It was determined that basic building blocks for the system could be represented by a fully automatic Teletypewriter switching system for communications, magnetic drum storage equipment for memory and processing of flight plan information, and automatic display boards for rapid data display and transfer. The proposed organization of this system is shown in Fig. 16.

Fig. 17 shows a display board for the large amounts of data that must be presented to the operator.

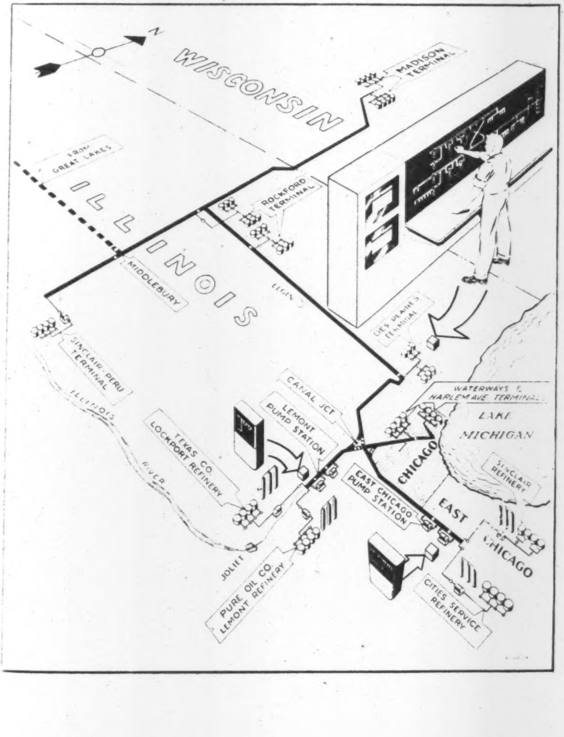
Conclusion

The story of the growth of railway signaling is a typical story of instrumentation and automation. It began with the track relay. Track circuits were examples of early automatic feedback circuits with built-in safeguards making them "self-checking" or "fail-safe." The early automatic signal systems mentioned were forerunners of today's concept of automation.

All of these early manifestations of instrumentation and automation were resolved as early as the 1920's into an extensive system known in the railway field as centralized traffic control, which had many of the control and feedback elements found in modern automatic control systems.

Today, thousands of traffic-control functions distributed over thousands of miles of rails are monitored and controlled from centralized points—and, through Centralized Transport Control, other industries now can take advantage of these time-proved principles and applications.

Fig. 14. Badger Pipeline, extending from the Madison Terminal in Wisconsin and the Sinclair-Peru Terminal in Illinois to the Cities Service and Sinclair Refineries in Illinois, is under the control of one CTC center.


N
WISCONSIN
MADISON TERMINAL
FROM GREAT LAKES
ILLINOIS
ROCKFORD TERMINAL
MIDDLEBURY
ELGIN
DES PLAINES TERMINAL
SINCLAIR-PERU TERMINAL
ILLINOIS RIVER
CANAL JCT
LEMONT PUMP STATION
TEXAS CO. LOCKPORT REFINERY
WATERWAYS & HARLEM AVE. TERMINALS
LAKE MICHIGAN
CHICAGO
SINCLAIR REFINERY
EAST CHICAGO PUMP STATION
EAST CHICAGO
JOLIET
PURE OIL CO. LEMONT REFINERY
CITIES SERVICE REFINERY

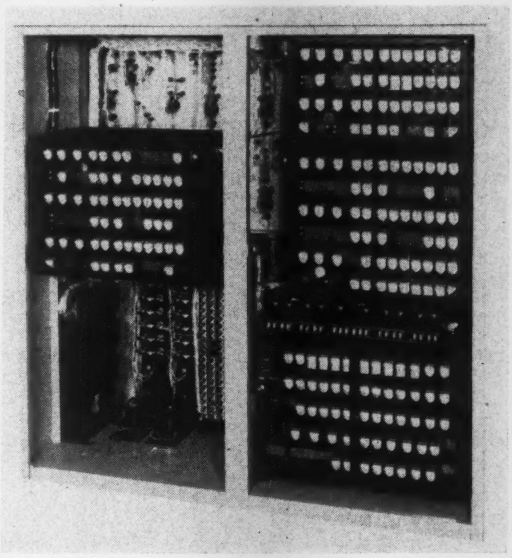


Fig 15. Typical control console for transmitting the coded signals for controlling a pipeline remotely.

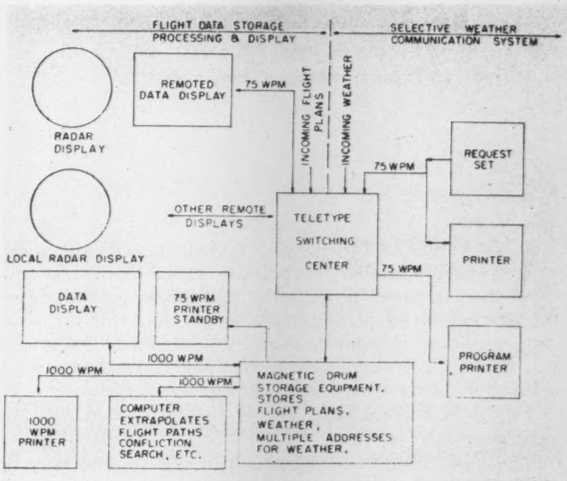

FLIGHT DATA STORAGE PROCESSING & DISPLAY
SELECTIVE WEATHER COMMUNICATION SYSTEM
RADAR DISPLAY
REMOTED DATA DISPLAY
75 WPM
INCOMING FLIGHT PLANS
INCOMING WEATHER
REQUEST SET
75 WPM
OTHER REMOTE DISPLAYS
TELETYPE SWITCHING CENTER
LOCAL RADAR DISPLAY
PRINTER
75 WPM
DATA DISPLAY
75 WPM PRINTER STANDBY
PROGRAM PRINTER
1000 WPM
1000 WPM
1000 WPM
MAGNETIC DRUM STORAGE EQUIPMENT. STORES FLIGHT PLANS, WEATHER, MULTIPLE ADDRESSES FOR WEATHER.
1000 WPM PRINTER
COMPUTER EXTRAPOLATES FLIGHT PATHS CONFLICTION SEARCH, ETC.

Fig. 16. Proposed system for air traffic control using Teletype switching center, Teleregister magnetic drum storage, etc. Data display is shown in Fig. 17.

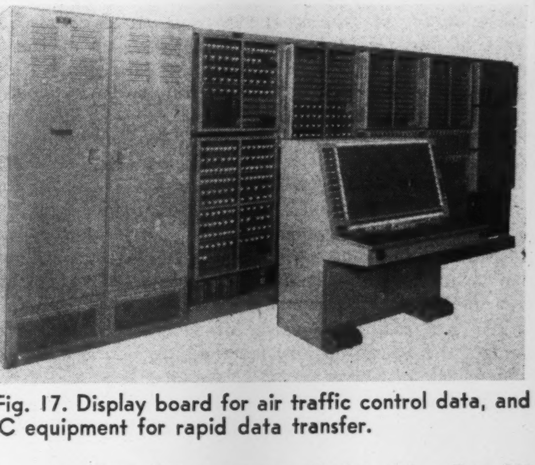


Fig. 17. Display board for air traffic control data, and CTC equipment for rapid data transfer.

Process Data

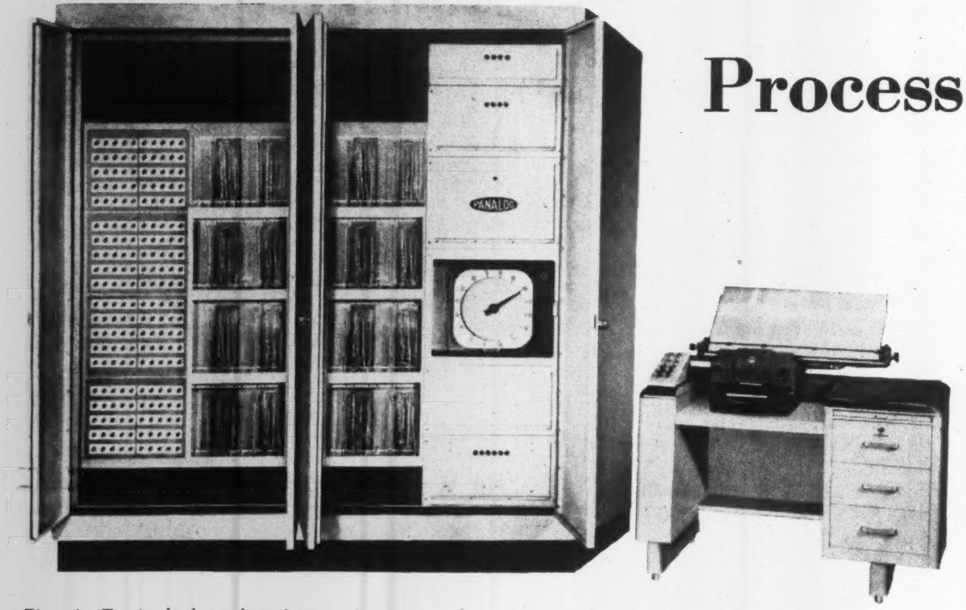


Fig. 1. Typical data logging system.

AN AUTOMATIC logging system periodically scans a large number of process variables (pressures, temperatures, flows, etc.) and prints and arranges the process variables in a manner whereby this information can be quickly and efficiently reviewed by an operator. Fig. 1 illustrates a typical equipment arrangement of a logging system with a centralized control room.

Fig. 2 is a block diagram of the components of the system.

The *input signals* are electrical in nature, and may be in the form of changes in voltage, current, or resistance.

The *scanner* is a sequential switching system, usually consisting of electrically operated stopping switches, relay trains, motor-driven switches or electronic scanning devices.

The *analog measurement system* is usually one of two types of systems in common use: The first utilizes the null-balance potentiometer principle wherein the input voltage is measured against a known slidewire voltage; in this system the input signal is converted into a proportional shaft rotation. The second system is electronic in design wherein a time varying reference converts a voltage level to a time difference; in this system the input voltage is converted into a proportional time signal.

The *analog-to-digital-converter* converts either the shaft position or the time signal into a digital output, which can be in turn converted into a code suitable for actuation of the electric typewriter by a *matrix*.

The *programmer* consists of several elements which control the operation and interlocking of the entire system.

The *off-normal memory* prevents repetitive printing of an alarm by printing only the time the particular point goes "off-normal" and the time at which it returns to normal. The memory may take the form of latch relays, capacitors, or neon lamps.

Any standard electric typewriter or Teletype machine can be operated from an automatic logging system provided the system has the proper analog-to-digital converter.

Measurement Factors

Thermocouples are a common temperature-measuring element in the range from −300 to +3000°F. The nonlinearity characteristic of the emf curve of thermocouples can be linearized easily by means of cams and tapped or tapered potentiometers if the analog input is available in the form of a shaft position. This is one advantage of the potentiometric type of measurement.

Resistance thermometers are also in common use. The nominal range of a high-speed bulb is usually from −20 to +300°F. One problem associated with resistance thermometers is that the element requires a three-wire circuit because one wire is required to eliminate ambient temperature change effect upon lead circuitry. To provide a compatible two-wire input, some type of conversion bridge network is required.

For *pressure measurement,* many transducers are available. Some use the differential transformer or the variable reluctance principle to achieve pressure to electrical conversion. Others use a variable resistance. Recent transducers include a low-cost bellows-operated transducer that uses 3 to 15 psi input pressure to move the wiper on a precision slidewire. For higher pressures it is necessary to use Bourdon tubes or strain gages.

Presented at Texas A&M Symposium on Instrumentation for the Process Industries, 1956.

Logging Systems

ROBERT J. MARMORSTONE
Panellit, Inc.

Although scanning and logging are the two basic functions of the modern automatic data logger, the system also uses electromechanical and electronic techniques for multiplication, square-root extractions, integration, time compensation, and analog-to-digital conversion. Automatic testing and standardization are also important features.

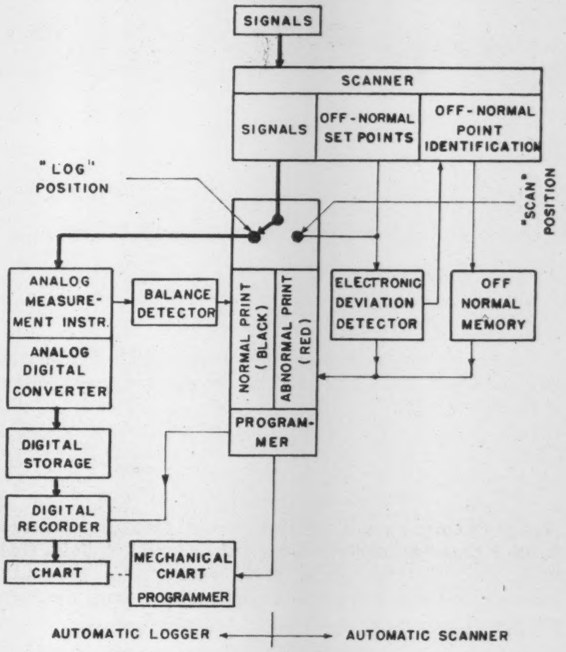

SIGNALS
SCANNER
SIGNALS
OFF-NORMAL SET POINTS
OFF-NORMAL POINT IDENTIFICATION
"LOG" POSITION
"SCAN" POSITION
ANALOG MEASUREMENT INSTR.
BALANCE DETECTOR
NORMAL PRINT (BLACK)
ABNORMAL PRINT (RED)
ELECTRONIC DEVIATION DETECTOR
OFF NORMAL MEMORY
ANALOG DIGITAL CONVERTER
PROGRAMMER
DIGITAL STORAGE
DIGITAL RECORDER
CHART
MECHANICAL CHART PROGRAMMER
AUTOMATIC LOGGER
AUTOMATIC SCANNER

Fig. 2. Block diagram of elements used in system shown in Fig. 1.

Flow transducers usually measure pressure differential and, therefore, are similar to pressure transducers—except that some provision must be made for square-root extraction because flow rate is proportional to the square root of the pressure differential. Square-root extraction may be accomplished simply by use of two linear ganged slidewires or by means of shunt resistors used in conjunction with a tapped potentiometer.

Multiplication with Potentiometers

The fundamentals of potentiometer multiplication illustrate how two potentiometers can be used for square-root extraction. Fig. 3 shows two potentiometers cascaded to perform multiplication. A constant voltage (E) is supplied to one end of the first potentiometer. The shaft rotation representing the first variable sets off a proportionate resistance X_1 on the first potentiometer, which has a total resistance R_1. The shaft rotation representing the second variable sets off a correspondingly proportionate resistance X_2 on the second potentiometer, of total resistance R_2. The voltage at the brush of the first potentiometer is $E\ (X_1/R_1)$; the voltage at the brush of the second potentiometer is $E\ (X_1/R_1)\ (X_2/R_2)$. As E, R_1, and R_2 are constants, the output $= K\ (X_1X_2)$.

The above is true only if the second potentiometer does not "load" the first—that is, it is necessary that the second potentiometer have a large resistance compared with the first potentiometer. This loading effect between ganged potentiometers can be avoided by means of isolating stages between them, such as cathode-follower amplifiers.

Square-Root Extraction

Fig. 4 illustrates a typical square-root circuit obtained by cascading a pair of ganged potentiometers.

The amplifier is a servoamplifier that moves both wipers so that e_2 always equals e_1 (input signal).

The ganging causes both potentiometer wipers to be at the same fractional position of their total travel. An es-

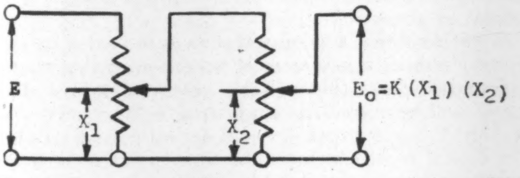

E
X_1
X_2
$E_o = K (X_1) (X_2)$

Fig. 3. Two cascaded potentiometers perform multipiation.

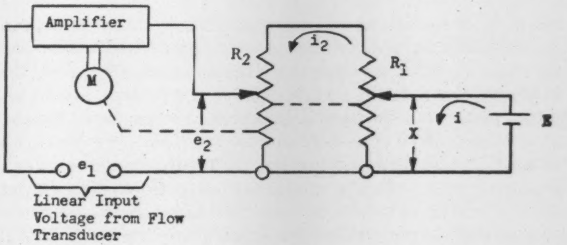

Amplifier
M
R_2
i_2
R_1
e_2
X
i
E
e_1
Linear Input Voltage from Flow Transducer

Fig 4. Ganged potentiometers perform square-root extraction.

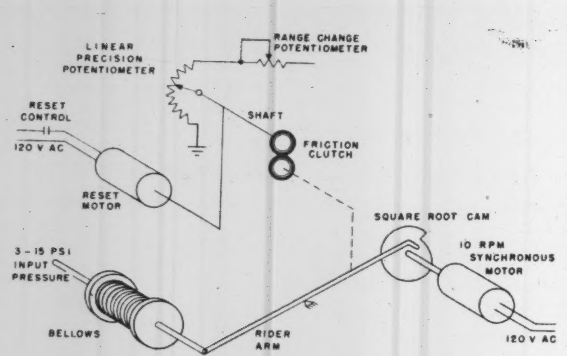


Fig. 5. Electromechanical integrator. Bellows positions rider on square-root cam, which controls time that friction clutch is engaged.

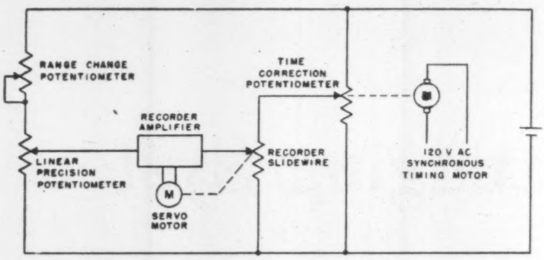


Fig. 6. Time compensation circuit uses synchronous motor geared to a time-compensating potentiometer.

sential design requisite for this circuit is that i be derived from a *constant-current source.* Therefore it follows that

$$i = E/K = \text{Constant} \qquad (1)$$

where E is the reference voltage obtained from the constant current source. The output voltage e_2 is

$$e_2 = i_2 \; (R_2) \; x \qquad (2)$$

where x represents the fractional position of total potentiometer travel. Current i_2 may be given by the expression

$$i = \frac{(E) \; (R_1) \; (x)}{(K) \; (R_1 + R_2)}.$$

Substituting (3) in (2) gives

$$e = \frac{(E) \; (R_1) \; (x) \; (R_2) \; (x)}{(K) \; (R_1 + R_2)}$$

$$= (\text{Constant}) \; (x^2)$$

Hence x (the shaft position of the servo) is a measure of the square root of e_2, which also is the input from the flow transducer (e_1).

Integration

Integration is a process of accumulation. Any device capable of receiving and storing physical variables and indicating the variable stored may be used as an integrator. In an automatic logging system provision for averaging flows and other variables over a period of time is necessary. Hence some type of time compensation is required when "on demand" logging of an averaged variable is incorporated in the logging system.

Integration can be performed electronically by means of charging current into a capacitor, or mechanically by means of a ball and disc.

Fig. 5 is an electromechanical integrator which converts a retransmitted differential pressure to an electrical signal proportional to average hourly flow. The bellows receives the differential pressure, and expands or contracts with variations in pressure. The rider arm attached to the bellows rides on a square-root cam, and also controls a clutch so that the engaged time of the clutch is proportional to the square-root of the pointer arm position—that is, proportional to instantaneous flow. As the cam rotates at 10 rpm, 600 samples of flow are taken each hour. The accumulated motion transmitted by the clutch is thus proportional to average hourly flow. The output motion of the clutch is transmitted through a gear train to a precision potentiometer which provides an electrical output proportional to total flow. Range, or scale factor, of the potentiometer is adjusted by means of a variable resistor in series with the potentiometer slidewire.

At the end of the integration period an electrical impulse from the logging system programming unit causes a reset motor to drive the potentiometer back to zero so that a new sample may be taken for the next time period.

On *pressure-compensated units* the pointer arm position determined by the bellows is modified by a second bellows through a mechanical multiplying linkage. Thus the pointer arm position represents the differential pressure corrected by the absolute pressure of the flow line.

Where necessary, a second output potentiometer is added to the end of the gear train for 24-hour accumulation. This unit also has an independent reset.

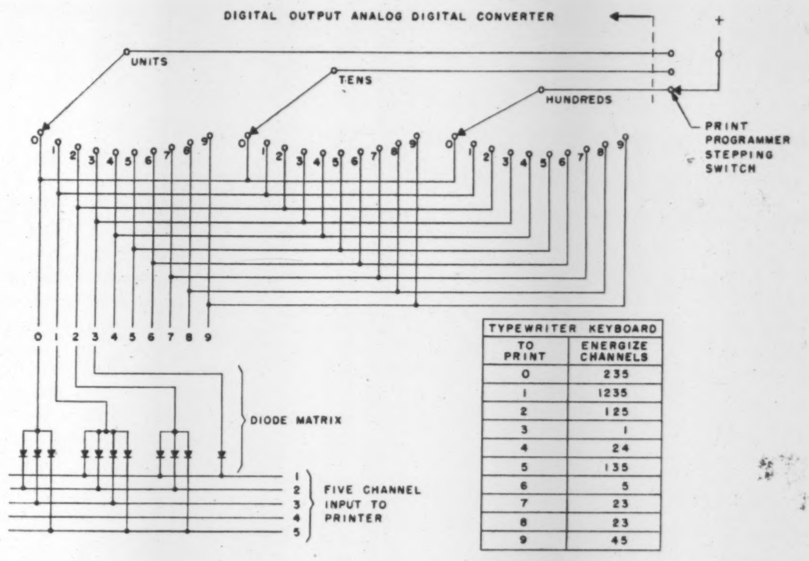
If the flow is read out at regular time periods no further correction is required. However, if the flow is read out some time before this regular time, some type of time compensation is required because the measurement is based on time.

Fig. 6 shows one method of *time compensation.* A synchronous motor is geared to a time-compensating potentiometer which varies the input reference voltage to the measurement system. Assume first that the output from the integrator corresponds to 100% flow and that a periodic log is taken at 1-hour intervals. If the nominal output from the integrator is 25 millivolts at full flow, the output at one hour is 25 millivolts. However, if an "on demand" log is initiated at thirty minutes, only one-half the output voltage would appear at the integrator terminals. It is therefore necessary to provide time compensation in the system.

Scanning

During the scanning cycle of the program the system sequentially compares each electrical signal representative of a process variable with that variable's own high and low limits. Simultaneously, it checks a memory unit relevant to the same variable to determine whether (1) the variable is currently normal or abnormal and (2) whether the variable memory indicates the variable was normal or abnormal.

In the event that a change of state as indicated by either a new alarm or a new normal condition of that variable is found, the variable will be quantized and a digital record will be made. The chart used in the system shown in Fig. 1 has sections devoted to off-normal readings. The digital record includes the time, point identification and magnitude of the variable. Distinction between a new alarm and a return to normal condition is accomplished by printing the magnitude in red if the variable is ab


DIGITAL OUTPUT ANALOG DIGITAL CONVERTER
+
UNITS
TENS
HUNDREDS
PRINT PROGRAMMER STEPPING SWITCH
0 1 2 3 4 5 6 7 8 9
DIODE MATRIX
1
2
3
4
5
FIVE CHANNEL INPUT TO PRINTER

TYPEWRITER KEYBOARD	
TO PRINT	ENERGIZE CHANNELS
0	235
1	1235
2	125
3	1
4	24
5	135
6	5
7	23
8	23
9	45

Fig. 7. Code and diode matrix for converting the decimal output of an analog-to-digital (decimal) converter to a 5-channel code suitable for operating an electric typewriter.

normal and printing it in black if the variable is found to be normal.

Alarm Detection

An electronic deviation detector is generally used for alarm detection. Abnormalities are detected by comparing amplified input voltages with alarm limit reference voltages.

Two basic methods of alarm detection may be used in an automatic logging system. The first utilizes a retransmitting slidewire within the null-balance potentiometer. At least one alarm-set-point potentiometer is provided for each point. Where high and low detection is required, two retransmitting slidewires and two set potentiometers must be used.

The circuit can be so designed that a positive voltage difference will trigger a thyratron. Automatic printout of that particular point will then occur. The two main disadvantages inherent with a system of this type are (1) slow-speed scanning results owing to the necessary balance time of the null-balance potentiometer and (2) slidewires require maintenance.

Electronic alarm detection involves no moving parts and permits high-speed scanning. In order to detect alarms within one F degree (iron-constantan), it is necessary that the detector sense a deviation of 25 microvolts from the alarm set voltage. The d-c difference voltage is first fed into a vibrating-reed converter which chops the voltage into an a-c signal. This voltage is then amplified, after which it triggers a thyratron if it is of proper value.

Alarm Memory

Individual alarm memory elements provide the feature of alarm printing only when a variable goes off normal and again when the variable returns to normal.

Without point alarm memory, an abnormal variable would be reprinted once each scan cycle until restored to normal. This would be valueless recording and would result in rapid fill-in of chart area making it necessary to use a plurality of log sheets for each twenty-four hour period.

An alarm memory unit has two stable states which are reversible by the application of appropriate signals. A neon lamp fulfills all specifications for a reliable memory device as well as providing a visual indication of its condition. Several long-life types have been developed for the computer industry during the past few years.

Logging

The manner in which information is represented to the operator is of utmost importance. For practical and useful plant operation a complete record of all vital variables should be automatically logged at regular intervals. Furthermore, a complete log must be made available "on demand" when required by operating personnel.

A novel log sheet is used in the data-logging system illustrated in Fig. 1. The log sheet is in the form of a continuous band or endless belt of paper. The automatic typewriter is so controlled as to record periodically the scanned values of all process variables in longitudinally spaced, segmental areas. Data on approximately 75 variables can be recorded in each segment of the chart. Thus, for 300 variables, four segments are required. The log sheet is preprinted with point numbers and measurement units at the top of each segment. Numerical data on the corresponding process variables are aligned in vertical rows in each segment under the corresponding process variable.

At the beginning of each log cycle the system automatically goes into a test and standardization procedure which sequentially standardizes all battery emf sources, checks the performance of the alarm detector, and also checks the calibration accuracy of the null-balance digital measurement system. If all of these checks are satisfactory, the typewriter prints an "x" in the test columns of the chart. If any fault is found during this test procedure, a system fault light on the control panel is energized and the alarm bell is sounded to call the operator's attention to the fact that the system is defective.

After the test signal is printed, the time base represented in hours and minutes is typed automatically at the beginning of each line.

Following the printing of a line in the first segment of the chart the typewriter indexes to the second segment where printing of the second group of variables occurs. This action is repeated until a line has been printed in the last segment. At this time, a line spacing control automatically positions the chart to receive printing in the "off-normal" section of the chart.

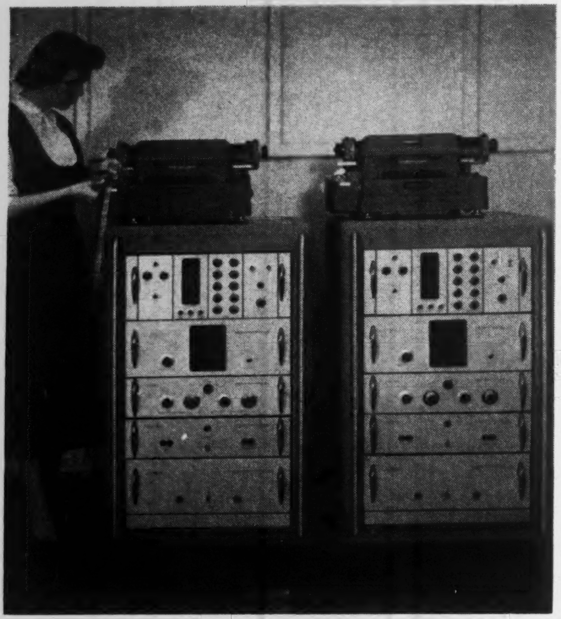


Fig. 8. Two data loggers used in an aircraft-testing program. Data are both printed out and punched on tape.

If the operator requires further information regarding process trends he can initiate an "on-demand" readout at any time. A complete log is then printed one line below the preceding periodic readout.

Space is provided at the bottom of each segment for twenty-four hour "averages" and "totals" printout.

Analog-Digital Converter

The three basic methods of analog-to-digital conversion are called (1) time base, (2) voltage comparison, and (3) spatial. *The first two are electronic in nature and rapid. However, the last is particularly adaptable to the digitization of a shaft position, such as the shaft of a null-balance potentiometer whose regular position is a measure of the input signal voltage. For example, if the input voltage is nonlinear, suitable linearizing cams or potentiometers can be used, as mentioned previously.

The output shaft of the potentiometer is coupled to a digital converter which converts the single shaft output to three (or four) separate shaft positions. These positions represent, respectively, the three digits of a number which represents the angular position of the shaft, which in turn represents the value of the variable. This type of converter is electromechanical in operation.

Converters of this type usually include three or four ten-position switches, the wiper contacts of which connect with contacts 0 - 9, which represent the digits of a three (or four) digit number. Fig. 7 illustrates a typical code and diode matrix which converts the decimal output of the converter to a five-channel code suitable for operation of an electric typewriter. The output of the converter can be in the form of a binary code or any other code of similar nature. In each case, however, the same design problem exists—namely, translation of the converter output to a code suitable for printer operation.

The system print programmer sequentially scans the hundreds, tens and units wipers of the analog-digital converter. If the wiper of the "hundreds" switch is in the zero position, channels two, three and five of the typewriter are energized. The translating magnets within the typewriter are so arranged that energization of channels two, three and five provide a zero print.

Systems

The actual physical construction of the automatic data handling system can vary widely depending on the requirements of the application.

Fig. 1 illustrates one type of installation utilizing a single typewriter on a control desk with a cubicle housing the remainder of the data handling system. The indicating self-balancing potentiometer in the cubicle is the measuring instrument which positions the shaft encoder to produce the digital output for each variable.

Fig. 8 shows two data handling systems which are part of an aircraft testing installation. In addition to the typewriter outputs, the experimental data are put on punched paper tape. This tape is coded so that the data can be further processed by computers or card punching machines.

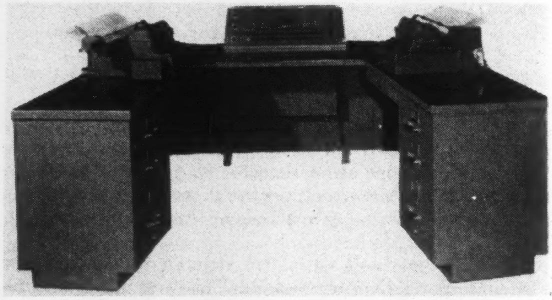


Fig. 9. Data logger used in a refinery. Sixty-eight variables are logged on each typewriter.

Fig. 9 illustrates an operator's desk which is part of a data handling system recently installed on a process unit in a large eastern refinery. Two typewriters are used, with sixty-eight variables being logged on each typewriter. In addition to the log sheet, the system produces a punched paper tape record containing the daily cost accounting data. The central part of the desk contains controls for the data handling system, a visual display panel with push-buttons for selecting the point to be displayed and a series of indicating lights which are actuated by the scanning system to signal any abnormal condition. There is no digital printing of abnormal conditions except when they occur during a normal log cycle. If a variable is outside of its normal limits during the log cycle, it will be printed in red instead of black.

The remainder of the data handling system, including the transducers, power supplies, integrators, and accessory equipment is housed in two cubicles which are mounted in back of a graphic control panel. Only the operator's desk is on the control-room operating floor.

Acknowledgment

Figures 8 and 9, and accompanying discussion, are by courtesy of Arthur H. Freilich, Data Handling Systems, Minneapolis-Honeywell Regulator Co., Phila., 44, Pa. This material was part of a paper "Data Handling Systems in the Process Industries, presented by Mr. Freilich at the Texas A&M Symposium on Instrumentation for the Process Industries, 1956.

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*See article "Analog-to-Digital Converters" on pages 911-917.

Control Valves—No. 5

Actuator Design

C. S. BEARD
Foster Engineering Company

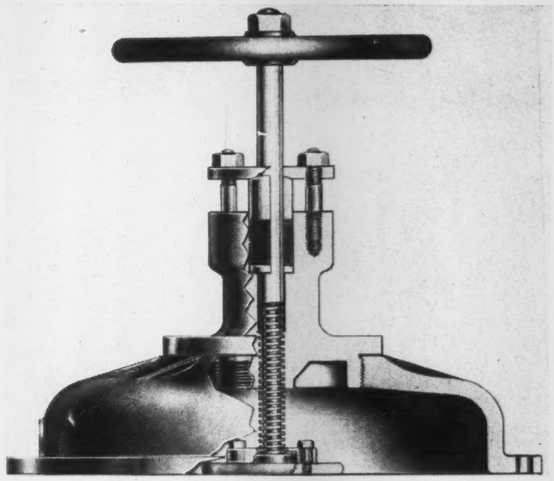

Fig. 5-1. Threaded handwheel is simplest method for manually closing an air-to-close valve.

A control valve has two basic parts—(1) a body, comprising plug and associated parts, and (2) an actuator, comprising means for operating the plug. Body designs have been dicussed previously. This chapter deals with the basic forces that the actuator must overcome, and with manual actuators which can be used with other actuators.

IT is sometimes difficult to establish a definite line of demarcation between the body and the actuator. The previous article dealing with valve bodies included all valve elements up to and including the stem packing. Any element beyond the stem packing will be considered part of the actuator mechanism. Actuators discussed in this and following chapters will include manual, diaphragm, piston type, electric, and combined electric and pneumatic or hydraulic actuators. This discussion deals with basic forces and design factors, and with manual operators which can be used with other types of actuators.

Force Factors

The actuator must overcome the inherent hysteresis in the movement of parts, the weight of moving parts, and the unbalanced forces across the valve seat. The actuator must have also sufficient power and stability to overcome the inertia effects in large valves, and sufficient speed of response to satisfy operating conditions.

Hysteresis and Weight Effects

Hysteresis is a result of friction between moving surfaces. Packing contributes to this effect because the packing must create a seal sufficient to hold line fluid within the body. Additional friction occurs in the guide. Very ne stem finishes, as smooth as 6 microinches, are used to minimize friction. Seal rings of the pistons in cylinder actuators also offer resistance to movement and are the cause for some hysteresis, although modern advanced constructions minimize this factor.

The valve plug and other moving parts must be positioned properly to obtain flow control. The weight of the lug, the diaphragm plate, the stem and other moving arts becomes a problem in large globe valves. Certain alve designs minimize this weight factor; the rubber sleeve valve and the butterfly valve with the shaft in the center of the wafer are examples of such designs.

Effect of Unbalanced Forces

The *unbalanced force* caused by pressure drop across the valve openings is the single most serious problem. As the plug assumes different positions, and as flow varies, the pressure differential across the valve will vary widely in magnitude, and can even change direction. The actuator must work against this force, which depends on (1) number of seats, (2) type of plug and (3) magnitude and direction of flow across seat. These three factors must be considered when selecting a valve actuator. Unbalanced force conditions for various combinations of these factors are described in the following:

(a) *Single-seated parabolic plug; flow tends to open valve.*—Initial force to hold the valve closed is equal to the product of the seat area times the pressure drop. This force apparently increases during the small initial movement of the inner valve, and then decreases rapidly as the valve opens. There is no reversal of direction of the unbalanced force exerted.

(b) *Single-seated parabolic plug; flow tends to close.*—Initial force required to open the valve is equal to the differential pressure times the difference in areas of the seat minus the area of the stem. The force curve is similar to case (a) except that the decrease is neither as rapid nor as great. There is no reversal of the forces.

(c) *Double-seated parabolic plug; inlet is between the seats.*—Initial force required to hold the valve closed is equal to the difference in areas between the upper seat (of a valve seating downward) and the smaller lower seat, times the differential pressure. At about 40% lift, the main valve is in equilibrium between opening and closing. As the opening is increased the force that tries to close the valve increases about ten-

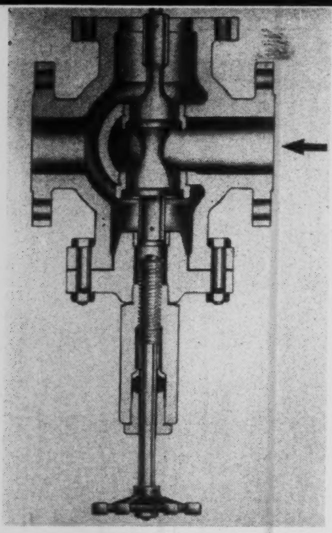

Fig. 5-2. Handwheel with threads in bottom flange forms manual operator for air-to-open valve, or where valve stem is moved upward for closing.

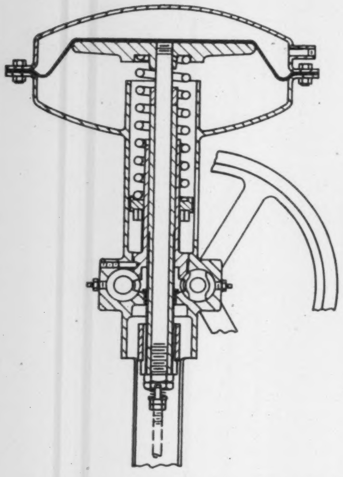

Fig. 5-3. Externally threaded sleeve can position the stem either upward or downward when handwheel is rotated.

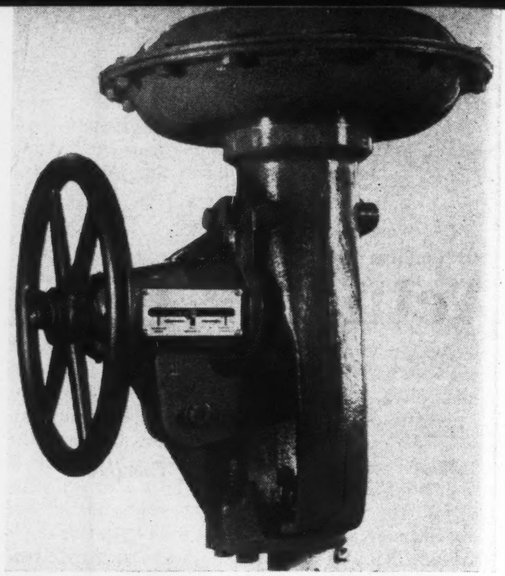

Fig. 5-4. Two sets of fingers are raised or lowered to position a crosshead in this manual actuator.

fold in proportion to the unbalanced area of the seats. There is a reversal of the unbalanced force exerted on the plug.

(d) *Double-seated parabolic plug; inlet is over the seats (reverse of c).*—The unbalance caused by unequal seat areas requires a force equal to the differential pressure times the difference in areas to open the valve. This force increases throughout the travel. From 85% to full open, the force curve for (c) and (d) is the same. There is no reversal of the forces exerted.

(e) *Single-seated V-ported plug; flow tends to open.*—Initial force to hold valve closed is the area times the differential pressure. This force decreases by only about 25% throughout the stroke. There is no reversal of force.

(f) *Single-seated V-ported plug; flow tends to close the valve.*—Initial force to open the valve is seat area times differential pressure. This remains nearly constant until the valve is about 75% open. From this point to fully open, the force drops to about 55% of the value in the closed position. There is no reversal in force.

(g) *Double-seated V-ported plug; inlet is between the seats.*—Force to hold the valve is the same as in (c). A point of equilibrium occurs at about 55% open. A force to close then develops, although not nearly as rapidly as with the parabolic plug. There is a reversal of force.

(h) *Double-seated V-ported plug; inlet is over the seats.* —Force required to open is the same as in (d). Force to continue opening increases throughout travel. There is no reversal of force.

(i) *Single-seated quick-opening plug; inlet is under the seat.*—Force tending to open valve falls off at fairly uniform rate to about 33 1/3% of the maximum at an opening equal to about ¼ of the diameter (maximum flow occurs at opening equal to diameter). There is no reversal of force.

(j) *Single-seated quick-opening plug; inlet is over the seat.*—Force tending to close the valve decreases at a fairly constant rate to about 25% of the maximum force. There is no reversal in force.

(k) *Double-seated quick opening plug; inlet is between the seats.*—Force to hold the valve closed is equal to the difference in seat areas times the pressure differential. The force tending to open the valve increases slightly as the valve is opened about 6 to 8%. It decreases (and the force reverses to tend to close the valve) at about 12% open. Above 12% open, the force tending to close increases to a maximum at about 50% open and the remains constant. At no time are any of the unbalanced forces large. There is a reversal of force.

(l) *Butterfly valve with shaft in center of the disc.*—In closed position there is no unbalanced force, but movement to open requires force to overcome the shaft friction. Increased force is required to open the valve, consisting of this thrust torque plus the unbalanced torque. The force reaches a maximum with disc somewhere between 60 and 85 degrees open (depending on operating conditions). At full-open position, there is no unbalanced force. Figs. 3-17 and 3-18 (shown in previous chapter 3) depict the force relationships. As the valve is closed, the force required to position the disc is the torque tending to close the valve minus the friction torque (which resists movement either way). This difference approaches an equilibrium at about 30 degrees open so that force must be exerted to continue closure. There is a reversal of force.

(m) *Valves consisting of flexible sleeves or diaphragms; line pressure causes opening.*—Force must be exerted against the opening just enough to oppose the line pressure times the exposed area of the diaphragm or sleeve at the opening position required.

(n) *Plug valves; ported plug opens or closes valve by 90-degree rotation of plug.*—Friction constitutes the most important force which must be overcome to turn the plug cock. This friction is caused by the static pressure of line fluid holding the plug face against corresponding body face. Additional friction is contributed by the tight seal between the face of the plug and the face of the body necessary to keep the valve from leaking. Some designs minimize the resistance of this seal friction by lifting the plug before it is rotated. This lifting requires force. Although a slight force can be exerted by the flowing fluid to further open a partly open plug cock, this

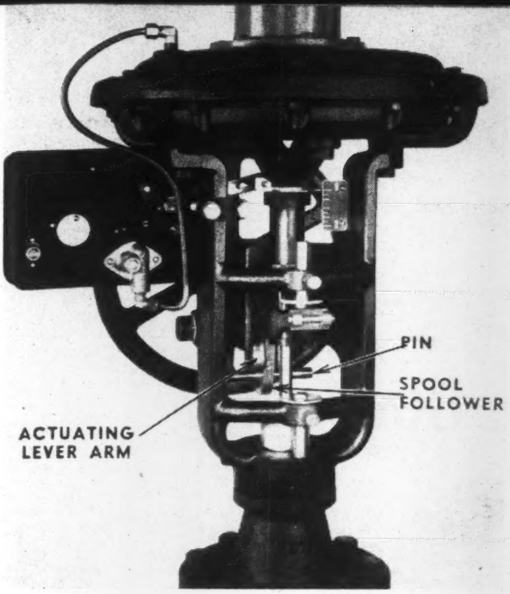

Fig. 5-5. Controlling pin locks lifting arm to this handwheel operator.

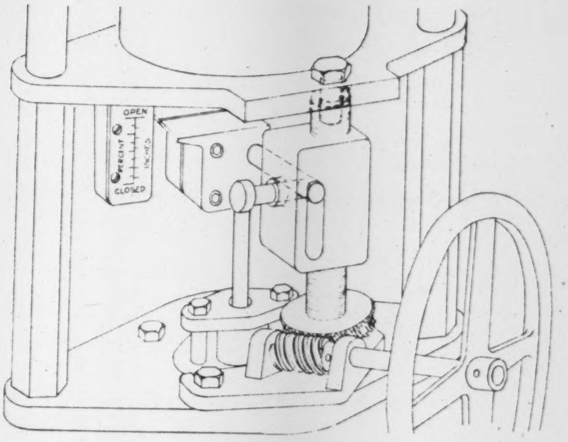

Fig. 5-6. Motion of block on threaded spindle operates valve when connecting pin is locked in place.

force is negligible compared to friction forces. There is no reversal of force exerted.

o) *Slide valves or gate valves*—The forces involved are frictional and are proportional to the pressure differential and the surfaces which are in contact during operation. There is no reversal of forces exerted.

Reversal of forces during opening and closing of a valve contributes to instability, as does the inertia of heavy parts (which also contributes to oscillation). These instability factors should be kept in mind throughout the discussion of actuators, which are becoming increasingly important as industry increases the volumes of liquids and gas flowing at high velocities, and as control of complicated systems requires faster actuators.

Manual (Handwheel) Operators

The control valve often must be provided with means for manual closing in event of abnormal or emergency conditions, including failure of the valve actuator. If it is of the air-to-close design, a threaded handwheel can be installed in the diaphragm case (Fig. 5-1).

This solution is simple but not wholly satisfactory because the spring must be relied upon for opening. As spring troubles are rare, however, this design is used widely. The handwheel can be installed in the bottom flange of the body (Fig. 5-2) when the stem is moved upward for closing, as in air-to-open valves. The stem then can be used as a limit stop. In either Fig. 5-1 or 5-2 the handwheel must be retracted for normal valve use, unless it is to be used as a stop or limit.

Butterfly valves can be operated by a handwheel and declutching system that releases the diaphragm operator. The same approach is used for plug cocks adapted to automatic operation by actuators.

Handwheel operation has been applied to the stem in such a way that the valve can be operated without the assistance of the spring. Such manual operators can open or close the valve against the load on the diaphragm or against the spring action, and hence can be used in event of faulty spring operation or ruptured diaphragm. Fig. 5-3 shows such an operator. The externally threaded sleeve around the stem will move the stem downward by pushing upward on the locknuts. This sleeve will raise the stem by pushing upward on the diaphragm plate. Movement of this stem is accomplished by a nut shown in the central housing. This nut cannot move up or down and, when rotated by the worm gear on the handwheel shaft, it raises or lowers the sleeve. The jacking screw is guided so that it does not rotate, but only moves vertically.

In another form of handwheel operator (Fig. 5-4) the rotation of the handwheel raises or lowers two sets of fingers. This action positions a crosshead, which will lift the stem when it contacts the upper nut of an adapter, and push the stem down when operating in the opposite direction.

In the design shown in Fig. 5-5, the actuating lever arm, operated by the handwheel, can be locked to the spool follower, which moves the stem by a controlling pin. The stem is moved by lining up the actuating lever arm with the slot of the spool follower so that the controlling pin locks the two together. This can occur in any position of the stem, and rotation of the handwheel moves the stem up or down from this point.

Movement of the stem in Fig. 5-6 is accomplished by raising or lowering the bar protruding from the stem connecting block. This is done by the worm-operated threaded stem carrying a block which moves the bar. During automatic operation of the valve, the bar rides within the slot but does not hit the top or bottom of the slot. To bring the side handwheel into operation, the handwheel is rotated to position the block so that a thrust pin may be snapped through the slot to hold the bar in place. This side handwheel may be positioned to limit either upward or downward movement of the stem. This design allows for easy installation of the handwheel mechanism in the field.

Control Valve Bypass

Mechanical failure of automatic control valves is rare. The high reliability of valve actuators has led to a trend toward elimination of the once-common three-valve bypass. However, the decision to do without a bypass must be preceded by careful study of the effect of valve failure upon safety, loss of product, etc. Systems carrying hydrocarbons to other volatiles, or which must be purged, should use a bypass. A handwheel is a must when there is no bypass.

Terminology recommended by The Fluid Controls Institute, Inc.

Standard Classification and Terminology for Power-Actuated Valves

IT IS well recognized that a standard classification and terminology should be developed to cover general classes of Power Actuated Valves to simplify and to clarify description and specifications and to allow all to speak the same language.

A certain amount of inconsistency continues to exist and is being perpetuated.

A unifying framework is presented below with definitions and underlying reasoning thereof. General adoption of such framework is recommended.

Who Should Sponsor This Work?

The Fluid Controls Institute Standardization Committee was well qualified to undertake this work and has received approval of it by the membership.*

Purpose

The first objective of this classification and terminology is to adopt a system which will result in unified and simplified framework embracing a majority of existing types.

The second objective is to preserve and to standardize on terms and meanings which have already broad acceptance by users, technical writers and which are described in manufacturers' catalogues, as indicated from the bibliography listed at the end.

Definitions of Standard Terminology for Power Actuated Valves

1. **Terminology and General Definitions.**
The following definitions give the meaning of the terms as used in this standard.

1.10 **Actuator**—a device to convert mechanical, fluid, thermal or electric energy into mechanical motion.

1.11 **Electric Actuator**—a device to convert electric energy into mechanical motion.

1.12 **Electric Motor Actuator**—a device in which rotation of electric motor is translated into mechanical motion.

1.13 **Hydraulic Actuator**—a device to convert hydraulic energy into mechanical motion.

1.14 **Hydraulic Motor Actuator**—a device in which rotation of hydraulic motor is translated into mechanical motion.

1.15 **Pneumatic Actuator**—a device to convert pneumatic energy into mechanical motion.

1.16 **Pneumatic Motor Actuator**—a device in which rotation of pneumatic motor is translated into mechanical motion.

1.17 **Thermal Actuator**—a device to convert thermal energy into mechanical motion.

1.18 **Spring and Diaphragm or Piston Actuator**—is one in which fluid energy acting on either side of diaphragm or piston causes mechanical motion.

1.19 **Springless Diaphragm or Piston Actuator**—is one in which fluid energy acting on either side of diaphragm or piston causes mechanical motion.

2.00 **Control Valve**—a valve with a power positioning actuator for moving closure member to any position relative to valve port or ports in response and in proportion to an external signal. The energy for a control valve actuator is provided from an independent source.

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*As adopted by The Fluid Controls Institute, Inc., (formerly National Steam Specialty Club) October 18, 1955.

FRAMEWORK OF CLASSIFICATION FOR VALVES

In following this standard, we should not lose sight that the intent here is to consider Power Actuated Valves as devices and types of mechanisms from manufacturer's and users' standpoint and not necessarily as a part of the process control loop.

To that end, the following framework of classification is adopted.

	HAND VALVES	POWER ACTUATED VALVES		
Components	Valve & Manual Actuator	Valve and Power Actuator		
Source of Actuator Power	Manual	Pneumatic, Hydraulic, Thermal, Electric, or Mechanical Power		
Character of Actuator	Manually Reset	Positioning		Two-position "Open-Shut" or "On-Off"
Class	Hand Valves	Control Valves	Regulators	Powered Valves
Type of Power Signal	Manual	Externally generated Manual or Automatic Power Signal	Self-Generated Power Signal	Externally Generated Manual or Automatic Power Signal
Function of Actuator	To hold manually set position of valve	To position valve in response to magnitude or duration of signal	To position valve in response to self generated signal	To move valve to "Open-Shut" position
Structural Differentiation of types	Gate, Globe, Plug, Slide, etc.	1. Diaphragm Control Valve. 2. Springless Diaphragm Control Valve. 3. Piston Control Valve. 4. Springless Piston Control Valve. 5. Motor (rotary) Control Valve.	1. Diaphragm actuated Regulator. 2. Piston actuated Regulator. 3. Bellows actuated Regulator. 4. Pilot actuated Regulator, etc.	1. Motor (rotary) driven valve. 2. Solenoid Valve. 3. Piston Valve.
Functional Classification	Stop Valve, Throttling Valves, etc.	Examples: Pressure reducing, Control Valves, etc. As dictated by signal	1. Pressure Regulators a) Back Pressure Regulators b) Reducing Regulator c) Pump Pressure Regulator 2. Temperature Regulators 3. Differential Pressure Regulators, etc. 4. Flow Regulators	By-Pass, Stop Valves etc.

Standard Terminology for Power Actuated Valves

STANDARD	NON-STANDARD
1 Actuator	Motor, Motor Operator, Operator Mounting, Topworks, Superstructure
2 Control Valve	Diaphragm Motor Control Valve Diaphragm Motor Valve, Automatic Regulating Valve, Motor Valve
3 Diaphragm Actuator	Diaphragm Motor, Diaphragm Motor Operator, Mounting, Topworks Superstructure
4 Diaphragm Control Valve	Diaphragm Motor Control Valve Diaphragm Motor Valve, Motor Valve
5 Pneumatic Actuator	Pneumatic Motor, Pneumatic Motor Operator
6 Pressure Regulator	Automatic Pressure Regulating Valve
7 Regulator	Automatic Regulating Valve

References (Webster)

1. To Actuate:	"Put in Action"
2. Actuator:	"One who or that which actuates"
3. Regulate	"rule, govern, control"
4. Regulator	"A thing that regulates" A. "an automatic device for maintaining specified values, or adjusting these values at will." B. "A Reducing Valve, or Steam Pressure Regulating Valve."
5. Motor:	"One who, or that which imparts motion, a rotating machine which transforms electrical energy into mechanical energy."
6. Operator:	"In general, one who or that which operates;" "One whose work is to operate a thing: brake operator, motor operator, etc."
7. Powered:	"having equipped with, capable of operating . . . with power."

2.01 **Typical Control Valves***
  a. Diaphragm Control Valve
  b. Springless Diaphragm Control Valve
  c. Electric Motor Control Valve
  d. Hydraulic Motor Control Valve
  e. Pneumatic Motor Control Valve
  f. Pneumatic Piston Control Valve
  g. Hydraulic Piston Control Valve

2.02 **Diaphragm Control Valve**—is one having Spring-Diaphragm Actuator.

2.021 **Springless Diaphragm Control Valve**—is one having a springless diaphragm actuator.

2.03 **Two-position ("ON-OFF") Actuator**—an actuator which produces "ON-OFF" forward and/or reverse mechanical motion.

2.04 **Positioning Actuator**—an actuator which produces mechanical motion proportional to the magnitude or the duration of the power signal.

.00 **Power Actuated Valve**—a valve with a power actuator which utilizes mechanical, fluid, thermal or electric energy to cause mechanical motion of the valve closure member.

.01 **Two-position Power Actuated Valve**—a valve with two-position power actuator whether electric, hydraulic, pneumatic, thermal or mechanical which drives valve closure member toward open or closed position in response to an external power signal.

3.02 **Motor**—a rotating machine which transforms fluid or electric energy into mechanical motion.

4.00 **Temperature, Pressure, Level or Flow Regulator**—is a valve with a positioning actuator using a self-generated power signal for moving closure member relative to the valve port or ports in response and in proportion to the changes in energy of the controlled variable.

The force to position closure member being derived directly from the same fluid.

4.01 **Typical Regulators**
  A. Functional Classification
    a. Pressure Reducing Regulator
    b. Back Pressure Regulator
    c. Temperature Regulator (Self Actuated)
    d. Level Regulator (Self Actuated)
  B. Structural Classification
    a. Diaphragm Actuated Regulator
    b. Piston Actuated Regulator
    c. Internal Pilot, Piston Actuated Regulator
    d. Bellows Actuated Regulator

4.02 **Pressure Regulator**—is a self operated controller in which the energy to position valve closure member is provided by the changes of pressure of the controlled variable. Examples:
  4.02a Pressure Reducing Valve.
  4.02b Pump Pressure Regulator (Pump Governor)

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*Attention is directed to the distinction between a "diaphragm ontrol valve" and a "pneumatic motor control valve." The latter ses a rotary pneumatic motor. The word "motor" is restricted to otating machines, as in definition 3.02—Ed.

4.03 **Temperature Regulator (Self Operated)—is** a self operated controller in which the energy to position valve closure member is provided by the changes of thermal energy of the controlled variable.

4.04 **Level Regulator (Self Operated)**—is one in which the energy to position valve closure member is provided by the changes of level of the controlled variable.

5.00 **Manual Control (Hand Control)**—a control in response to human perception to the changes in controlled variables.

6.00 **Power Signal**—is the energy applied to the actuator.

7.00 **Valve**—a body with one or more ports and a closure member which opens, shuts or partially obstructs one or more ports. (Webster)

7.01 **Valve Port**—a controllable opening between passages, e.g., one which can be closed, opened, or varied.

7.02 **Valve Closure Member**—a part of valve which is positioned to close, open, or to partially obstruct valve ports.

Objections to Some Definitions Related to General Subject of Power Actuated Valves

Control Valve is a term fully sanctioned by many agencies, manufacturers buyer's specifications, and technical literature on the subject.

And although "Control Valve" in reality is a controlled valve, this is well understood; the same is true of ASME-702b **Final Control Element** which is actually a CONTROLLED ELEMENT.

ASME (52-SA-29) makes no distinction between controller (instrument) and regulator (valve), therefore the ASME definition is too broad to be accepted without qualification. "Regulator" and "Controller" may be presumed synonymous, but the accepted usage in industry is to refer to **instruments as controllers, valves as regulators.** Therefore, both should be recognized as such in their respective places.

SAMA Tentative Standard 15, 1953—Definition 2.4. Inconsistency is seen in the last paragraph of definition: "The Pneumatic Motor Operator may be a Diaphragm Motor, Piston or other Power Operator.

Why is it "Diaphragm Motor" but not also "Piston Motor"? nor "other Power Motor Operator"?

Obviously, Diaphragm, Piston, Spring Diaphragm or other Power Operators, or Actuators, have no basic distinction by which one must be called "Diaphragm Motor" unless a fundamental part of it is a rotating energy converter, which it is not.

It is sincerely hoped that ASME and SAMA Terminology Committees reconsider desirability of revising definition to restrict and to associate word "motor" with only rotating energy converters.

The above analysis and recommendations were developed by the following other members of the Standardization Committee of the Fluid Controls Institute and subsequently adopted by the membership at its regular Fall meeting, October 18, 1955.

Nikolai Belaef—Klipfel Valves, Inc.
Eric A. Bianchi—Mason-Neilan Regulator Co.
A. M. Capper—Continental Equipment Co.
L. S. Dysart—Fulton Sylphon Division
W. Davis Douglas—Minneapolis-Honeywell Regulator Co.
David Golner—Hammel-Dahl Co.
A. J. Hanssen—Black, Sivalls & Bryson, Inc.
Cecil Johnson—Fisher Governor Co.
John C. Koch—Conoflow Corp.
J. R. Lawler—Lawler Automatic Controls, Inc.
John S. Leslie—Leslie Co.
H. T. Wentworth—Atlas Valve Co.

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Instruments, Control Valves, Air Diaphragm-Operated, DuPont, Standard Engr. Specs. SR 121V.

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Material Requisition Form D41-A (Diaphragm Control Valve), Foster Wheeler Corporation.

Control Valves, Pneumatic or Hydraulically Operated, General Specification No. 15-5, The Standard Oil Company (Ohio).

Terminology of Control Valves

W.D. WASHBURN
Allied Chemical
& Dye Corp.

and

RUSSELL MILHAM
The Foxboro Co.

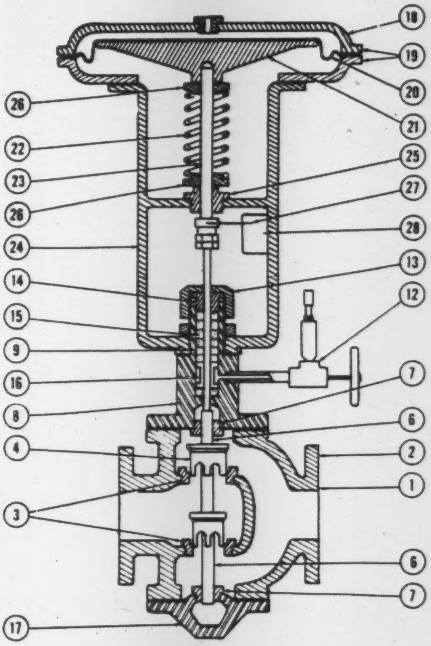

Fig. 1. Elements of a Diaphragm Control Valve.

A SUGGESTED partial Classification of Process Control Valve Terminology is outlined below. It provides for the terminology presented herein and includes areas requiring further activity.

Process Control Valves

- 1.00 Method of Operation
  - 1.01 Pneumatic
    - 1.011 Diaphragm
      - (a) Spring opposed
      - (b) Pneumatically opposed
    - 1.012 Piston
      - (a) Spring opposed
      - (b) Pneumatically opposed
  - 1.02 Hydraulic
    - 1.021 Diaphragm
      - (a) Spring opposed
      - (b) Hydraulically opposed
    - 1.022 Piston
      - (a) Spring opposed
      - (b) Hydraulically opposed
  - 1.03 Electric
    - 1.031 Solenoid
    - 1.032 Electric Motor
  - 1.04 Mechanical
    - 1.041 Float-operated
    - 1.042 Other mechanical means
  - 1.05 Combinations of the Foregoing
- 2.00 Diaphragm Control Valve
  - 2.01 Valve Body Assembly
  - 2.02 Diaphragm Motor Assembly
- 3.00 Additional Terminology
  - 3.01 Capacity
  - 3.02 Flow Coefficient
  - 3.03 Linear Flow Characteristic
  - 3.04 Equal Percentage Characteristic
  - 3.05 Unit Sensitivity
  - 3.06 Rangeability
  - 3.07 Valve Trim
  - 3.08 Dead Band
  - 3.09 Pressure Span
  - 3.10 Leakage
  - 3.11 Tight Closing
  - 3.12 Spring Rate
  - 3.13 Action
    - (a) Air-to-Close
    - (b) Air-to-Open
    - (c) Direct Diaphragm Motor
    - (d) Reverse Diaphragm Motor

2.00 **Diaphragm Control Valve** (Fig. 1): A Diaphragm Control Valve is a combination of a Diaphragm Motor Assembly designed for pneumatic operation and a Final Control Element consisting of a Valve Body Assembly.

2.01 **Valve Body Assembly** is an assembly of a housing and associated internal parts including a movable part which opens, shuts or partially obstructs one or more ports.

2.01a (2) **Valve Body** is a pressure vessel constituting the housing for the Valve Body As-

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Abstracted from ASME Paper 55-A-91, contributed by the Instruments and Regulators Division for presentation at the ASME Diamond Jubilee Annual Meeting, Chicago, Ill., November 13-18, 1955.

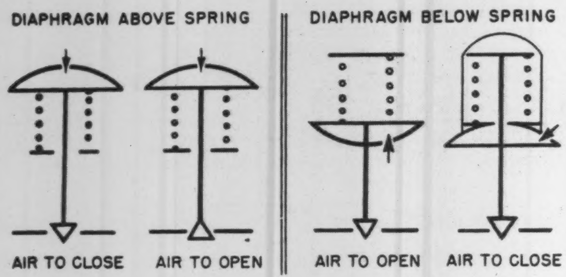

Fig. 2. Valve actions.

sembly with inlet and outlet flow connections. The connections may be screwed, flanged or welded, according to A.S.A., British or A.P.I. standards. The valve body may be Single Seated, Double Seated or Three-Way.

2.01b (3) **Seat Ring** is an integral or replaceable ring with an opening which may be partially or completely obstructed by a movable part for the purpose of flow regulation.

2.01c (4) **Valve Plug** is a movable part which provides a variable restriction with its associated Seat Ring. For characteristics and functional reasons there are many forms of Valve Plugs:

Needle Plug is Single Seated, cone shaped with length much greater than maximum diameter; it may be a truncated cone, a parabolic form, a slab sided cylinder, or a cylinder with modified V-shaped cutouts.

V-Port Plug consists of (a) a cylinder which is hollow below the seating surface with V-shaped cutouts having their apexes located adjacent to the seating surface of the plug, or (b) a solid cylinder with V- or modified V-shaped cutouts in the cylinder arranged with the apexes located successively from just below the seating surface to the bottom center of the cylinder.

Contoured Plug is a solid single or double seated plug having a symmetrical profile.

2.01d (5) **Valve Plug Stem** is a rod for connecting the Valve Plug to a source of motion.

2.01e (6) **Valve Plug Guide** is an integral part of the Valve Plug, which, in conjunction with a suitable Guide Bushing or Bushings, aligns the movement of the Valve Plug. The Valve Plug Guide may be a post on one or both ends of the Valve Plug or a skirt or wings integral with the Valve Plug. When skirt or wings are part of the Valve Plug Guide, the Seat Ring or Rings usually act as the Guide Bushing.

2.01f (7) **Guide Bushing** is a bushing in which the Valve Plug Guide moves.

2.01g (8) The **Bonnet Assembly** is a bolted or screwed housing assembly attached to the Valve Body, through which the Valve Plug Stem moves, containing a means for sealing against leakage of fluid along the Valve Plug Stem to the outside of the Bonnet and providing a means of support for the Diaphragm Motor.

The means of sealing against leakage may be a stuffing box assembly (9) with suitable packing material or a sealing bellows, one end of which is pressure-tight connected to the valve stem and the other end pressure-tight connected to the bonnet. The housing may be provided with Radiation Fins or an Extension Bonnet and/or Valve Plug Stem Guide Bushing (7), and/or Lubricator (12).

2.02 (18) **Diaphragm Motor** is a fluid-pressure operated, spring-opposed diaphragm assembly for positioning the Valve Plug in relation to the operating fluid pressure.

2.02d (22) **Diaphragm Spring** is an elastic member of helical wound wire with specified characteristics. The compressive force of the spring opposes the force produced on the Diaphragm Plate by the fluid pressure on the Diaphragm.

2.02e (23) **Stem Extension** is a separable addition to the Valve Plug Stem to join the Diaphragm Plate and Valve Plug Stem.

2.02f (24) **Yoke** is a structure by which the Diaphragm Case Assembly is supported rigidly on the Bonnet Assembly.

2.02g (25) **Spring Adjuster** is an adjustable means for varying the initial compression force of the Diaphragm Spring.

2.02h (26) **Spring Seat** is a seating surface for one end of the Diaphragm Spring.

2.02j (27) **Travel Indicator** is an attachment to the Valve Plug Stem or Stem Extension by which the Valve Plug position is indicated on a reference scale.

3.00 Additional Terminology

3.01 **Capacity** of a Control Valve is the rate of flow of specified fluid at stated flowing conditions and pressure drop across the valve at the maximum opening.

3.02 **Flow Coefficient** indicated as C_v is the number of U. S. Gallons of water per minute, at 60°F, that will flow through a valve at maximum opening and a pressure drop of 1.0 psi measured in the inlet and outlet pipes directly adjacent to the Valve Body.

3.03 **Linear Flow Characteristic** is one in which equal increments of Valve Plug movement will produce equal quantities of flow change at a constant pressure drop for incompressible fluids and with constant upstream and downstream pressures for compressible fluids. Mathematically, it is expressed as: $y=kx$ and $dy/dx = k$, where y = Flow, percent; x = Valve Plug travel, percent; k = Constant.

3.04 **Equal Percentage Flow Characteristic** is one in which equal increments of Valve Plug movement will produce equal percentage changes in flow at a constant pressure drop

Glossary of Terms

Non-Standard	Recommended Standard
Direct Acting	Air-to-Close
Reverse Acting	Air-to-Open
Body Head Stuffing Box Body Top Bonnet Yoke Plate	Bonnet Assembly
Flow Rating	Capacity
Modified Parabolic Parabolic Ratio Solid Form—Equal Percentage Solid Form—Linear Throttling	Contoured Plug
Hysteresis	Dead Band
Flexible Diaphragm	Diaphragm
Activator Air Motor Diaphragm Assembly Diaphragm Motor Operator Diaphragm Operator Diaphragm Top Direct Diaphragm Motor Motor Positioning Diaphragm Motor Reverse Diaphragm Motor Superstructure Topworks Valve Operator	Diaphragm Motor
Loading Spring Spring	Diaphragm Spring
Percentage Throttling	Equal Percentage
Capacity C_v	Flow Coefficient (C_v)
Proportional Straight Line Straight Proportional	Linear
Flow Ratio Turndown	Rangeability
Inner Valve Seats Seats	Seat Rings
Lift Stroke	Travel
Characterized V-Port Equal Percentage V-Port Straight-Sided V-Port	V-Port
Body Body and Trim Valve	Valve Body Assembly
Inner Valve Plunger	Valve Plug
Guide Guide Post Valve Guide Valve Plug Post	Valve Plug Guide
Lower Stem Plug Stem Valve Stem	Valve Plug Stem

for incompressible fluids and with constant upstream and downstream pressures for compressible fluids. Mathematically it is expressed as:

$$dy = mdx, \text{ where } m = \text{constant.}$$

3.05 **Unit Sensitivity** (S_v) is the percentage change in flow resulting from increasing the valve opening 1% of the total travel.

3.06 **Rangeability** is the ratio of maximum to minimum flow within which flow characteristics are maintained within stated limits.

3.07 **Valve Trim** consists of those internal components within the Valve Body Assembly which can be contacted by the line fluid, including Seat Rings, and Valve Plug Stem, Valve Plug Guide, Guide Bushing, Lubricant Ring and Packing Follower. Nominal Trim indicates that Seat Rings and Valve Plug sizes are the maximum size for the given nominal valve size. Reduced Trim indicates that Seat Ring and Valve Plug sizes are smaller than the nominal.

3.08 **Dead Band** is the span through which the fluid pressure to the Diaphragm Motor may be varied without initiating a movement of the Valve Plug.

3.09 **Operating Pressure Span** is the difference between the high and low values of fluid pressure on the Diaphragm to produce the required Valve Plug Travel.

.10 **Leakage** is the flow in percent of rated capacity between the Seat Ring or Rings and the Valve Plug when the Valve Plug is seated under designed closing pressure on the Diaphragm.

.11 **Tight Closing** means zero leakage.

.12 **Spring Rate,** as applied to the Diaphragm Spring, is the force in pounds required for a deflection of one inch.

3.13 **Action** (Fig. 2)

3.13a AIR-TO-CLOSE indicates an action in which an increase in fluid pressure to the Diaphragm Motor causes the Valve Plug to approach the seat.

3.13b AIR-TO-OPEN indicates an action in which an increase in fluid pressure to the Diaphragm causes the Valve Plug to move away from the seat.

3.13c A DIRECT DIAPHRAGM MOTOR is one in which fluid pressure is applied above the diaphragm.

3.13d A REVERSE DIAPHRAGM MOTOR is one in which fluid pressure is applied below the diaphragm. The terms "Direct" and "Reverse" should be applied only to Diaphragm Motor action, not to the valve assembly.

Acknowledgements

The authors express appreciation for the assistance given by: Bardford A. Chase, The Foxboro Company, Foxboro, Mass.; Malcolm B. Hall, The Foxboro Company, Foxboro, Mass.; Brendan P. White, Nitrogen Div., Allied Chemical & Dye Corp., Hopewell, Va.; A.S.M.E.-I.R.D. Terminology Committee

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"Automatic Control Terminology" Prepared by Terminology Committee of Instruments and Regulators Division, A.S.M.E., Copyright 1954.

Control Valve Specification Sheets of: Catalytic Construction Company, Chemical Construction Corporation, E. I. du Pont de Nemours & Company, Inc., Esso Research & Engineering Company, Foster Wheeler Corporation, The Lummus Company, Nitrogen Division, Allied Chemical & Dye Corporation, Stone & Webster Engineering Corporation

ELECTRONIC

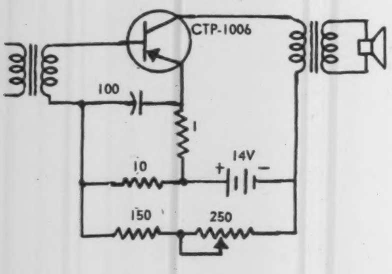
MILTON H. ARONSON
Instruments & Automation

and

CHARLES F. KEZER
Key Electric Corp.

CLASS-A TRANSISTOR AUDIO AMPLIFIER OUTPUT STAGE

This circuit is designed for use in automobile radio receivers where it is desired to operate directly from the storage battery, thereby eliminating the need for a vibrator supply.



Circuit also requires much less battery power than the vacuum-tube amplifier it replaces because the transistor efficiency is higher than that of tubes. Specifically, the power drain of the transistor amplifier is

$$EI = 14.2 \times 0.375 = 5.33 \text{ watts.}$$

A comparable vacuum-tube amplifier using a type 14C5 beam power tube (6V6 equivalent) delivers 2.0 watts at 8% distortion but the 14C5 tube requires 3.36 watts of heater power at 14 volts, and 6.12 watts of plate and screen power at 180 v dc, for a total supply drain of 9.48 watts. Thus the tube amplifier requires 78% more power from the battery to obtain comparable output power.

Although better efficiency can be obtained from a vacuum-tube amplifier by using higher plate-supply voltages, if the power losses of the vibrator supply were considered the advantage of the transistor amplifier becomes even greater.

Supply Voltage: 14.2 v (typical actual terminal voltage of a nominal 12-volt battery).
Collector Current: 0.375 amp
Signal Source Impedance: 10 ohms
Load Impedance: 30 ohms
Audio Driving Power: 2.2 milliwatts
Power Output: 2.2 watts
Total Harmonic Distortion: 7%
Power Gain: 30 decibels
Source: Clevite Transistor Products, 241-257 Crescent Street, Waltham, Mass.

DUO-DIODE LIMITER CIRCUIT

A refinement of a previous circuit (Simple Square-Wave Generator, *Instruments & Automation*, May 1955), this circuit provides a convenient method of limiting, or clipping, at predetermined input voltage levels.

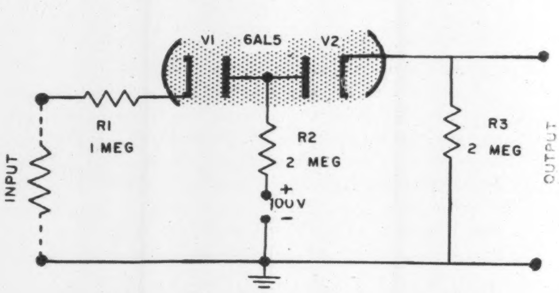
In the circuit shown, limiting occurs at ± 50 v levels (of input signal); output remains between 0 and + 50 volts.

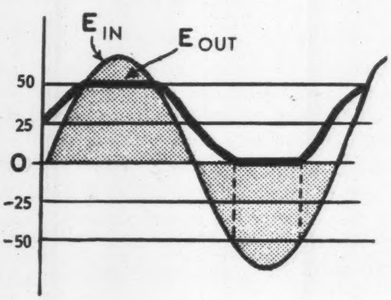
When the input voltage is zero, both diodes are conducting (source must provide a resistive path to ground), and resistors R1 and R3 are effectively in parallel. As their parallel resistance is 0.67 megohm, they form a 4:1 voltage divider with R2, and a voltage of 25 v, or E/4, appears at the output. Thus the output contains a direct-current component of +25 v. Input voltages not exceeding the limiting levels are attenuated by a factor of two at the output. Both diodes are conducting throughout this range of input (—50 to +50 v), and the signal passes through the 2:1 voltage divider formed by R1 in series with the combined resistance of R2 and R3 in parallel.

As the input rises above 0, the current in V1 decreases, allowing the output voltage to rise correspondingly (see curve) until the input voltage reaches + 50v. For higher input voltages, diode V1 is cutoff. Hence the output voltage remains at + 50 v, as established by the 2:1 voltage divider (R2-R3) across the 100-v reference voltage E.

For negative input voltages, increasing current is drawn through R1 and diode V1, producing a corresponding decrease in output voltage. When the input voltage decreases to —50 v, potential of the common plates has fallen to zero, as has the output voltage. For still more negative input voltages, the negative voltage present at the common-plate point cuts off diode V2 and the output remains at zero potential.

In the above explanation, effects of diode resistance and self-potentials have been neglected. These effects are small in the circuit shown but might have to be taken into account when limiting levels of 1 or 2 v are used.





CIRCUITRY

The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

Other variations of the circuit can be made. For example, by using a negative reference voltage and reversing connections to each diode, the same limiting action will be obtained, but the d-c component of the output voltage will be negative.

It is possible to adjust the limiting levels by choosing the resistor values, without changing the reference voltage E. For symmetrical limiting, resistor R1 must be equal to the resistance of R2 and R3 in parallel.

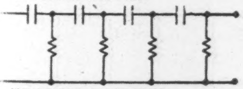
Source: C. F. Kezer, Key Electric Corp., Westbury, N. Y.

PHASE-SHIFT OSCILLATOR IS FREQUENCY MODULATED FROM 2700-3300 CPS

This circuit was designed to have a center frequency of 3000 cps which can be linearly deviated ± 7.5% by a d-c voltage. It has been used in a telemetering guided-missile-test system. In order of importance, the design characteristics were (1) frequency stability must be high, (2) amplitude modulation must be low, (3) linearity of frequency deviation must be good, (4) harmonic content must be low.

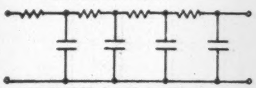
The phase-shifting sections that can be used include (1) the 3-section high-pass, (2) the 3-section low-pass, (3) 4-section high-pass, (4) 4-section low-pass, and (5) 2-section low-pass and 2-section high-pass networks, some of which are shown. Any of these can be designed to give the required network phase shift. The low-pass networks have less harmonic content because the higher harmonic frequencies are attenuated in the shunt capacitors; however, the high-pass network has the advantage that the capacitor coupling makes possible the use of the network between the plate and grid of the oscillator with no extra coupling capacitor. Another advantage of the low-pass filter is that the input capacitance of the tube (which can be high because of Miller effect) is added to the last capacitor.

4 - SECTION HIGH PASS



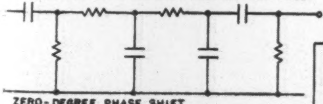
180-DEGREE PHASE SHIFT

4 - SECTION LOW PASS

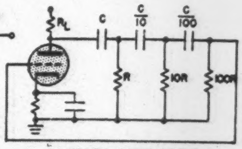


180-DEGREE PHASE SHIFT

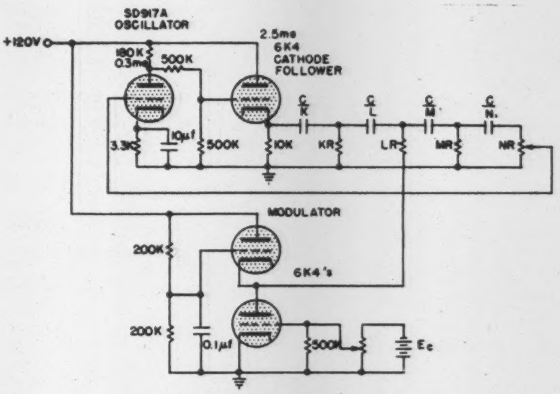
2 - SECTION LOW PASS & 2 - SECTION HIGH PASS



ZERO-DEGREE PHASE SHIFT



TAPERED NETWORK



KR = 4348 — 400 (output impedance of cathode follower) = 3948 ohms
LR = 15,000 (nominal) ohms
MR = 39,130 ohms
NR = 117,400 ohms
C/K = 11,500 uuf
C/L = 3835 uuf
C/M = 1278 uuf
C/N = 426.1 — 70 (oscillator input capacitance due to Miller effect) = 356.1 uuf

The R-C constant of each section is usually the same because the design equations are simplified. However, it is common to "taper" the sections so that a sharper attenuation curve results. (A "tapered network" is one in which R values of each section are increased whereas the C values are decreased, maintaining the R-C value constant.) A "tapered oscillator" is shown also.

As stability is a prime factor, a 4-section network was chosen in preference to the 3-section. As amplitude modulation is undesirable, the 180-degree network is preferred to the zero-degree network. Either the high-pass or low-pass networks could be used; the 4-section high-pass network was chosen. (If the frequency had been much higher the low-pass might have been preferable because the Miller-effect capacity of the tube could have been thrown in with the last network capacitor without affecting the network characteristics.)

A cathode follower is used to drive the network. The use of a network with a taper factor of 10 would have added stability, but was impractical because the first network resistor would have been too high or the last too low. (This could have been overcome by using another cathode follower between the first two and last two sections.) However, a taper factor of 3 was selected as a compromise. An R-C value of 5.002 x 10^{-5} was selected from the attenuation curve.

The modulator varies the effective value of the center resistor leg of the network (LR) from 6500 ohms (with E_C of -5.8 v) to 30,000 ohms (with E_C of -6.8 v). This changes the frequency from 3320 cps to 2725 cps. Frequency varies linearly with applied modulation voltage in this range.

Output: 3000 cps with E_C of -6.33 v; 3320 cps with E_C of -5.8 v; 2725 cps with E_C of -16.8 v.

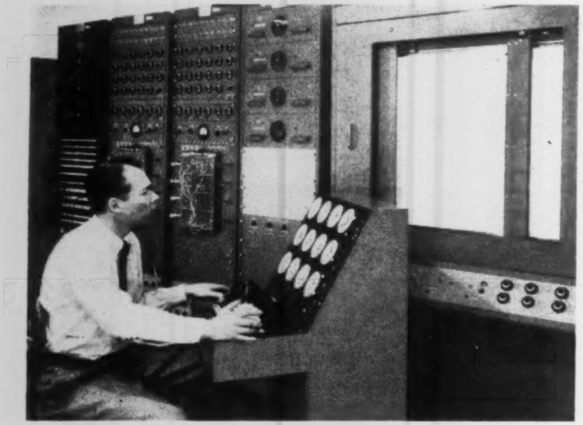
Amplitude Stability: Flat within 0.1 db over the 15% frequency change.

Frequency Stability: Depends on stability of modulator voltage. Supplying self bias to the modulator via a cathode resistor reduces the deviation sensitivity but increases the frequency stability. Frequency stability is about 0.2% with such self bias.

Source: "Analysis and Design of R-C Phase-Shift Oscillator Networks," by K. A. Morgan, NRL Report 3676, Naval Research Laboratory, Washington, D. C.

Aviation ⇄ Instrumentation

PILOT George Smith (shown at right center) became the first man to survive a supersonic bailout (777 mph) at low altitude (6500 ft). But it took the work of the Human Factors Group of North American Aviation, Inc., to analyze the forces and reactions involved. Pilot Smith is shown watching some of the tests. The other pictures show typical instrument activities at other NAA activities—at Rocketdyne, Autonetics, Propulsion Field Lab. and the Los Angeles plant.

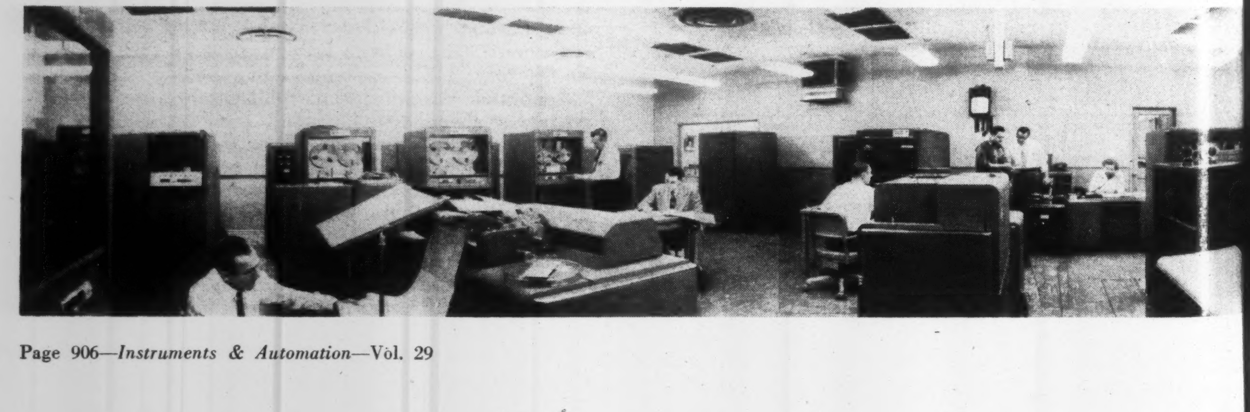


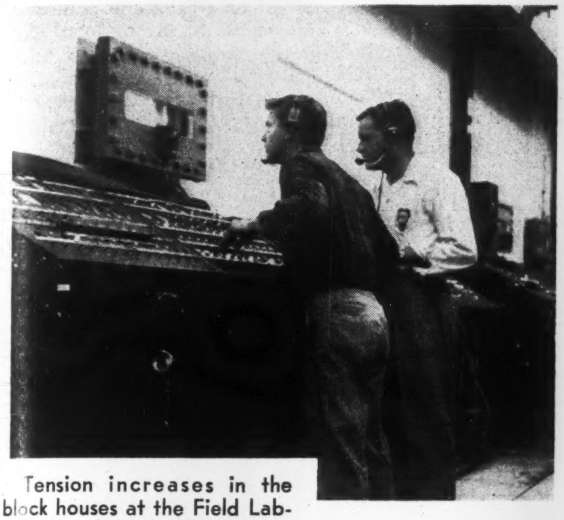
Performance of automatic pilot systems can be checked on this console. Autonetics research engineer Richard Fike "flies" a simulated airplane.

Assembly of precision instruments requires new standards of cleanliness in shop areas. Ruth Buttery is inspecting bearings for flight control systems in a dust-free room.

This compact Autonetics product, a self balancing potentiometer can monitor temperature ranges between minus 60 to plus 2,000 degrees Fahrenheit.

A 180-DEGREE PANORAMA OF THE

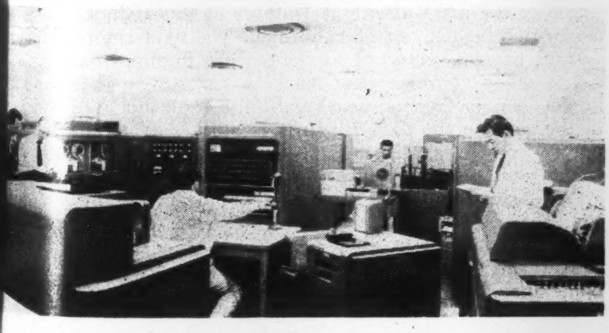




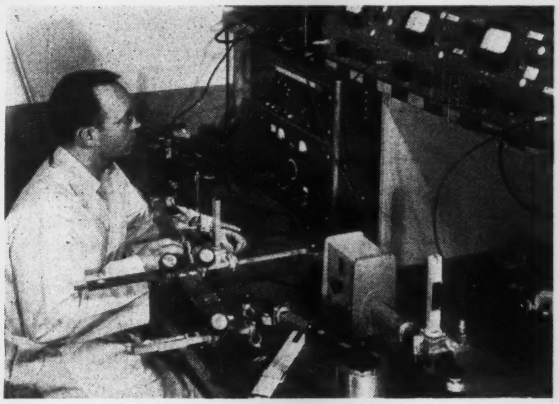
Tension increases in the block houses at the Field Laboratory of Rocketdyne as an engine is about to be fired. Engineers peer intently through slits in concrete walls at tests 500 feet away.

In the instrument shack pilot Smith views the instruments which record telemetered data.

COMPUTER ROOM IN LOS ANGELES

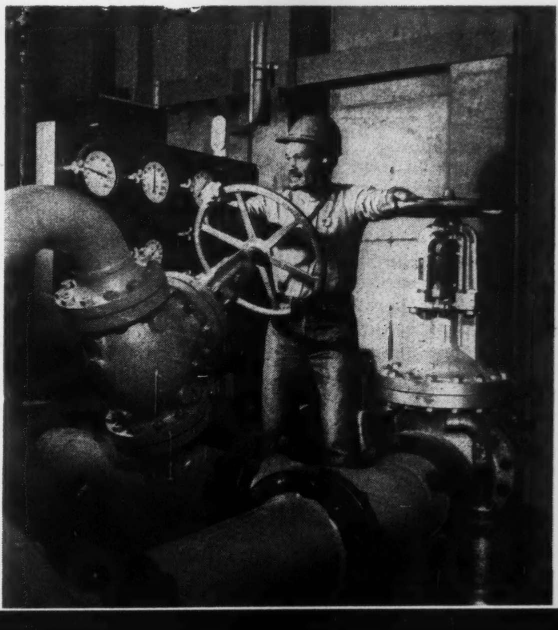


Autonetics employees here are "jigging" the main wiring harness for the MG-4 fire control system.



Research engineer Bruce Boyer is testing microwave portions of a radar system.

Sam McNaghten makes final settings on a High Flow Bench operation at the Propulsion Field Laboratory.



AIR POLLUTION CONTROL

Air pollutants include smoke, dust, hydrogen sulfide, and other forms of contaminants associated with industrial processes. The Midland plant of Crucible Steel uses smoke recorders, dust control via electronic precipitators, H_2S analyzers, and wind recorders to control and minimize plant effect on air pollution.

M. L. MAY, Swindell-Dressler Corp.

STEEL MANUFACTURE requires blast furnaces, soaking pits, and other processes involving combustion and waste gases. The waste gases carry air pollutants of many forms—smoke, dust, odorous hydrogen sulfide, etc. This article reports on the techniques used at Midland Plant of Crucible Steel for measurement and control of such pollutants.

Smoke Control

Smoke results from incomplete combustion. The Midland Plant uses a smoke recorder to control the smoke for its producer-gas-fired soaking pits. This instrument consists of (1) a light source which projects a beam of light, (2) a photocell which is actuated by the beam and which is connected to (3) an indicator and recorder. Signal lamps, operated by a solenoid switch, are connected in parallel with the recorder circuit. The indicator set also contains an Amperite tube (to maintain a constant voltage supply), an amplifier which amplifies the signal from the photocell, and calibrating rheostats.

Waste gases from the pit interrupt the light beam; the quantity of smoke present determines the amount of light energy which reaches the cell. The phototube changes the light energy to electrical energy which operates the indicator, recorder, and solenoid switch.

Smoke concentration is shown by the pointer of the indicator; a record is taken only of time and duration by a two-pen instrument. When a predetermined smoke density is exceeded the solenoid switch for the signal lights is actuated (simultaneously with the movement of the pen) as an indication of excessive smoke emission.

One of the many desirable features of this unit is the ease with which it can be calibrated. The light source is focused on the center of the photocell. Combustion of fuel is set to obtain a clear stack. A rheostat in the indicator box is then adjusted until the indicator is just off the zero on the dial. All light is blocked from entering the cell for a blackness check by covering the lens of the photocell. Another rheostat in the indicator box is then adjusted until the indicator points to five on the dial. A repeat reading is required to check the first adjustment (showing a clear stack). In event that the "clear" and "blackness" readings do not repeat, adjustments should be made. A critical smoke density is pro-

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Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, 1955.

duced at this time to set the recorder and solenoid switch. Fuel and air are adjusted to give a smoke density, usually #2 Ringelman, which should not be exceeded. This is the maximum smoke density permitted by most ordinances. A third rheostat in the indicator box is then adjusted until a small red light on the box is lighted.

The light source and cell are designed to allow air circulation from the atmosphere near the lens to reduce the rate of dust accumulation. Provisions are made also for circulating compressed air when pressure conditions exist. Ease of maintenance is illustrated by the fact that at Midland a quick dusting of the lenses by a rag only once a week is usually sufficient to maintain satisfactory operation. The unit is mounted on a stack outside the building; stainless-steel covers were installed to reduce the corrosive effects of the atmosphere. Similar units, installed on the boilers at the Park Works of Crucible Steel, are designed for automatic control of overfire air to reduce smoke. Excellent results have been obtained.

Dust Analysis

Metallurgical operations emit dust-laden gas. In some cases, such as the blast furnace, the gas can be used as a fuel if the amount of entrained solids is reduced. The dust loading of the cleaned gas can be measured continuously by instrumentation.

Blast-furnace-gas dust loading is analyzed and recorded at Midland by photoelectric methods. The recordings show the effectiveness of the operation of the electric precipitator in the coke plant. The instrument consists of two photoelectric cells and a light source mounted on opposite ends of a six-inch sampling tube eighty inches long. A circular-chart electronic recorder indicates the amount of dust.

A sample of gas is introduced at the center of the tube and flows to the outlets at each end. Variations in dust loading change the electromotive force generated by each cell and position the recording pen accordingly.

Use of two photoelectric cells makes the instrument insensitive to line-voltage variations. The output of the cells is applied in opposite polarity to the recorder so that it records the difference in electromotive force generated by each cell.

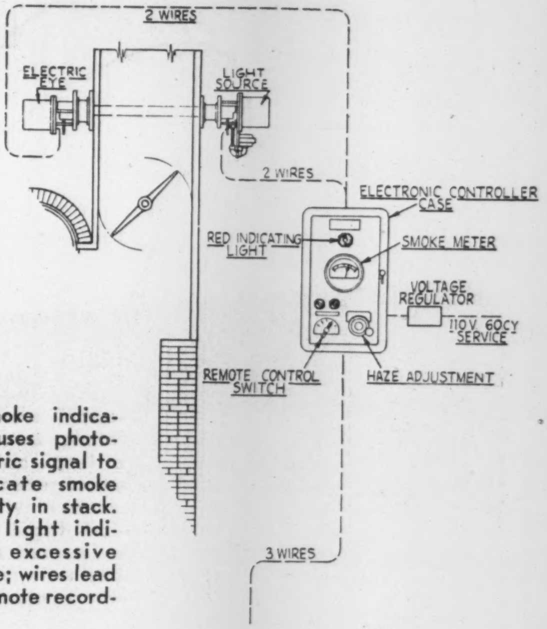
Dead air space is provided to reduce the dust deposit on the glass covering the analyzing cell and light source. A small amount of dry air is injected through pipe sections in front of the lamp and cell and allowed to flow into the sampling tube. Thus the gas sample is prevented from passing close enough to the glass to deposit dust.

A chart graduated from 0 to 100 is used; it requires calibration for dust loading. The thimble method is used to obtain actual weight of dust. Results are converted to grains/cu ft and plotted against the chart reading for the same period of time. Periodic samples of dust loading should be taken to check the calibration.

Distribution of Contaminants

The techniques discussed apply to control of air pollution at the source. It is just as important to know the distribution of air contaminants in the atmosphere as it is to know their origin and quantity. An instrument developed by the Industrial Hygiene Foundation is applicable to this phase of the problem.

The apparatus consists of a bellows-type pump operated by a synchronous motor. A sample of atmosphere is drawn through a filter paper on which the fine particulate matter is collected. After two hours the filter paper is replaced and a new sample is taken—the spots then are evaluated by a photoelectric cell. For this evaluation, a clean portion of the filter paper is moved into the beam of a light source which is positioned to give a scale reading of 100. Another reading is then taken from one of the sample spots. The ratio of the two readings is proportional to the particulate matter on the paper.



Smoke indicator uses photoelectric signal to indicate smoke density in stack. Red light indicates excessive smoke; wires lead to remote recorder.

Odor Detection

A similar unit using treated filter paper is used for measuring *hydrogen sulfide* in the atmosphere. Fine particulate matter is first removed from the sample by another filter before it passes through the treated filter paper. To get accurate results the treated filter paper must be protected from attack by hydrogen sulfide in the surrounding atmosphere, which is not being sampled. Exhaust from the pump is directed into the protecting cover to maintain a slightly positive pressure. A color change occurs in the portion of the filter paper which absorbs the hydrogen sulfide; the darkness of the discoloration is proportional to the amount of hydrogen sulfide in the sample. The spot on the filter paper is analyzed in the same manner as the smoke sample. A chart supplied by the manufacturer is used to convert the spot density ratio to parts per million of hydrogen sulfide in the atmosphere.

Wind Direction and Velocity

Wind direction and velocity are two variables which are important when analyzing an air-pollution problem. Useful records of these variables have been obtained at Midland by an *Aerovane*. The body of this instrument is similar in shape to an aeroplane fuselage. A three-bladed propeller is attached to one end and a rudder to the other end. Mounting on a ball-bearing base allows this unit to move to any position of the compass rose.

A transmitter, positioned by the vane, sends a direct-current signal to the wind direction indicator, a unit which is similar to an aircraft instrument. *Wind speed* is indicated by another remote position-indicator operated by a speed-measuring primary unit which consists of a magnetic-drag tachometer mechanism driven by a rotor. The mechanism is similar to that of an ordinary automobile speedometer.

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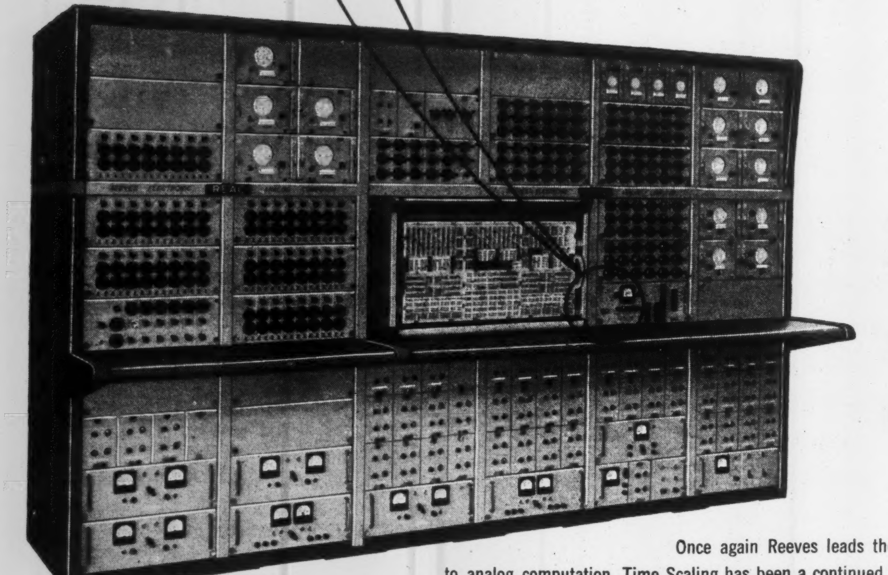

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"Time Scale Check" is another example of Reeves' pioneer engineering in the analog computer field. Reeves developed the first Electronic Analog Computer, and the list below gives some of the other important Reeves "firsts" since that time. Reeves is continually striving to improve its product and give you the very best in analog computers. Why not put this experience to work for you?

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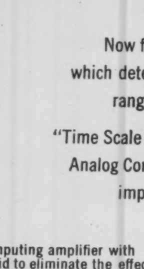

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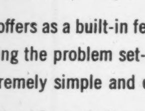

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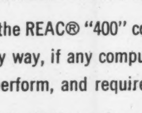

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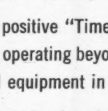

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Digital Automation—No. 8

Analog-to-Digital Conversion

This thorough discussion of digital conversion presents the three basic techniques—time, voltage feedback, and space encoding. The principles and operation of each are presented, complete with discussion of relative features.

MARTIN L. KLEIN
FRANK K. WILLIAMS
HARRY C. MORGAN

Rocketdyne Div.,
North American Aviation, Inc.

INFORMATION about the state of a process ordinarily is in the form of an electrical signal from a transducer measuring pressure, temperature, displacement, acceleration, and so on. A large variety of such transducers is available which produce an electrical signal in proportion to the phenomenon being measured. For digital automation, data handling, switching, computing, and other operations most readily carried out in pulse or digital form, it is necessary to have this electrical signal in the form of a pulse code or in some type of digital representation.

Although a few transducers directly provide digital-type output (Fig. 8-1), most transducers for process variables provide an analog-type output signal at the present state of the art. The result is that if we are to progress from an analog representation of the information to a digital form, an analog-to-digital converter must be used.

There are several commercial types available, many others under development. Although most converters appear much different at first sight, they all operate principally either on an *electromechanical* principle or on an *all-electronic* principle. The former class operates slowly, taking perhaps ten conversions per second. The latter all-electronic group is capable of as many as a million or more conversions per second.

The analog signal to be converted to digital form is usually either a voltage or a shaft position, particularly the angular position of a rotating shaft. In industry, where many variables are measured and recorded by instruments with a rotating shaft, the latter type of conversion is particularly important. As it is simple to convert voltage to shaft rotation and vice versa, there is no clear distinction between the two types of analog signal input. However, the choice of encoding technique may depend on whether it is voltage or a shaft position that is to be digitized. For example, space-encoding technique would probably be chosen for the latter use; time or feedback encoding for the former—if high rates of conversion are desired.

Converters, whether electromechanical or electronic, operate on one of three principles:

1. *Time encoding* (essentially a time measurement); also called time-base or sweep-time encoding.
2. *Feedback encoding* (essentially a voltage comparison); also called voltage-comparison encoding or encoding by parts.
3. *Space encoding* (essentially a physical representation of the code).

The time-base and voltage-comparison techniques can be all-electronic in circuitry and can now be used to obtain conversions at rates above 100,000 per second. The readout rate of space-encoding converters is much less because the coded pattern must be positioned mechanically, and is therefore in the order of several hundred conversions per second.

Each of these techniques has advantages and disadvantages, as will be discussed. However, before investigating these techniques, let us investigate the basic requirements of an analog-digital converter.

Basic Requirements

Conversion Rate

To make a conversion from an analog trace to a digital representation we first must be prepared to give up the continuous nature of the analog record. Fig. 8-2,A shows a continuous analog-type record of a phenomenon, such as an electrical signal from an analog transducer. First, we must break this curve up into discrete intervals and accept a finite reading in digital form as representing the amplitude at each interval. Fig. 8-2,B shows the analog trace broken in such a manner into a series of plateaus. If the plateaus are made narrower by increasing the *rate of conversion,* we get a closer and closer approximation to the original analog trace being digitized. Note that the rate at which the discrete digits are read is of great significance in converting an analog trace to digital form. The conversion or readout rate is thus the first characteristic of importance.

Conversion Accuracy

The second basic requirement is that each reading must be made with sufficient accuracy. If the reading

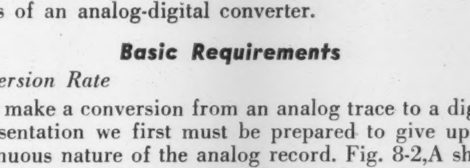

Fig. 8-1. Some transducers, such as this Vibrotron transducer for pressure, provide digital output signals directly. However, most transducers for process variables provide an analog-type signal and an analog-to-digital converter is required if digital techniques are to be used.

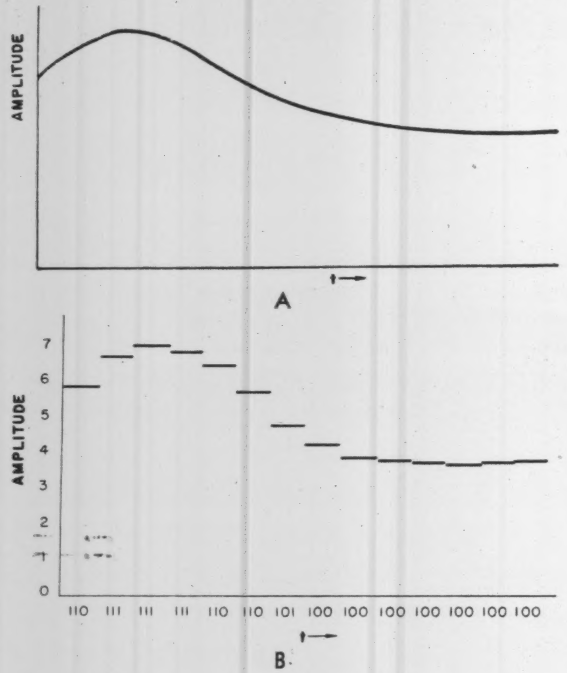

Fig. 8-2. First step in digitizing analog record of Fig. 8-2, A is to break up time scale into discrete intervals. Second step is to measure amplitude of curve at each interval. Third step is to indicate the amplitude in some binary code. The 3-bit code shown permits accuracy of only 1 part in 8 (2^3); a 7-bit code would have accuracy of 1 part in 128 (2^7); a 10-bit code 1 part in 1024 (better than 0.1%).

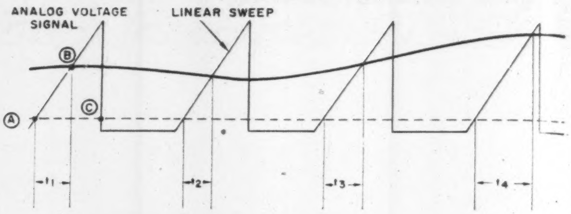

Fig. 8-3. Time-base encoding. A linear sweep voltage is made to intersect the unknown analog voltage—that is, to sweep up to a voltage higher than that of the analog signal. The time for the linear sweep to move from reference level (A) to the same amplitude as analog signal (B) is thus proportional to the analog signal amplitude. As the amplitude of the analog signal is converted to a proportional time, the principle is called time-base encoding.

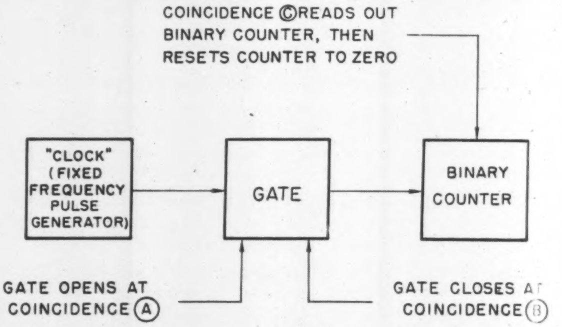
COINCIDENCE Ⓒ READS OUT BINARY COUNTER, THEN RESETS COUNTER TO ZERO
"CLOCK" (FIXED FREQUENCY PULSE GENERATOR)
GATE
BINARY COUNTER
GATE OPENS AT COINCIDENCE Ⓐ
GATE CLOSES AT COINCIDENCE Ⓑ

Fig. 8-4. Circuit for converting time intervals (t_1, t_2, etc. of Fig. 8-3) into a binary count. The gate is opened for the time interval (t_1, t_2, etc.). The number of "clock" signals that pass through the gate in the interval is counted on the binary counter.

at each discrete interval is made with an accuracy of 10%, at no time is the digital reading better than a 10% approximation to the curve, even at the exact point of reading.

Suppose we wish to read the analog trace of Fig. 8-2 in binary code—that is, to express the amplitude of each plateau by a series of pulses of equal height, the presence of a pulse representing a 1 and its absence a 0. If we are willing to accept an accuracy of conversion of 1 part in 8, we can specify the trace amplitude in only three bits (between 000 and 111), as shown by the binary representation of the height of each plateau at the bottom of Fig. 8-2,B. The series of pulses shown at the bottom of Fig. 8-2,B is thus a digital representation of an analog trace. Each 3-bit pulse would occur at the beginning of each predetermined time interval.

To improve the *accuracy* of the conversion at each interval we need to improve the resolution of the binary code. The maximum accuracy of a 3-bit code is 1 part in 8; if we represent the amplitude of each plateau by a series of 7 pulses, the conversion could have an accuracy of 1 part in 128 ($2^7=128$). This would be equivalent to plotting the curve of Fig. 8-2,B against an amplitude scale of 127 units, rather than the 7 units shown. Similarly, a ten-pulse binary code provides a possible accuracy of resolution of better than 0.1% ($2^{10}=1024$). An analog-digital converter must be capable, therefore, of providing a pulse code (some form of binary code) that expresses the amplitude of the analog trace it is converting at the specified instant of conversion, to the desired accuracy. This accuracy, or resolution, is a function of the number of bits in the code.

Conversion Duration

The time required to complete one conversion is another factor of importance. Converters with parallel outputs (all pulses presented simultaneously) usually can complete a readout more rapidly than those with series outputs (pulses presented one after the other). The conversion duration is obviously related to the conversion rate.

Ambiguity

An error in one of the most significant bits of a pulse code can be serious, and such errors can result when the circuit has to "decide" whether to produce a "0" or a "1" when it is exactly half-way between the two conditions—a point of always possible ambiguity. Special anti-ambiguity techniques are used in almost all converters to eliminate this possibility of ambiguity.

With these basic requirements for an analog-digital converter in mind, let us now examine the principles of time, voltage feedback, and spatial encoding. Commercial examples of each type will be given in the next chapter, following this discussion of the principles and techniques of each type.

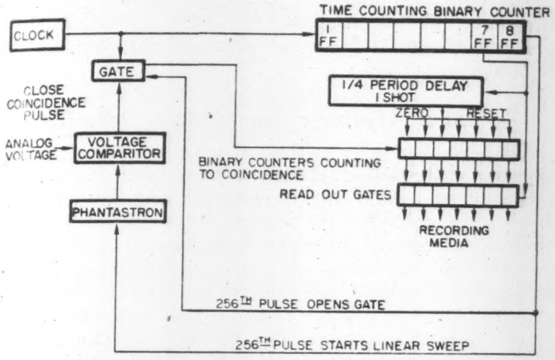

Fig. 8-5. Block diagram of a typical time-base encoding system. Seven flip-flops are used to obtain a maximum count of 128 ($2^7 = 128$). Resolution is thus 1 part in 128. Note that the phantastron sweep generator is triggered on every 256th pulse by the output of the eight "Time Counting Binary Counters" shown at top. This gives the circuits a 128-pulse "resting" interval between each 128-pulse sweep-and-count interval.

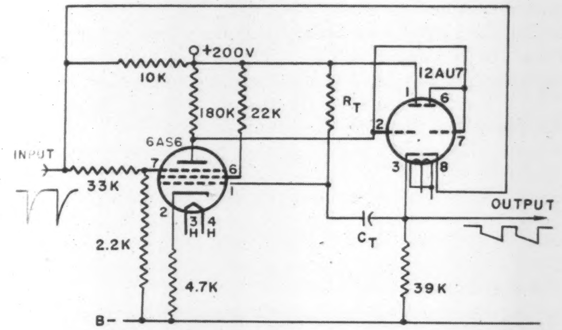

Fig. 8-6. Phantastron circuit for generation of a linear sweep.

Time Encoding

Perhaps the most used and highly developed method of converting signals from analog to digital form makes use of the principal known as *time encoding.* Time encoding makes use of two circuits which are simultaneously operated to provide the analog-to-digital conversions. These circuits are (1) a linear *sweep* circuit, and (2) a *counting* circuit.

The principle of time-base encoding is shown in Fig. 8-3. It is called "time-base encoding" because the amplitude of the analog voltage signal is converted into a proportional *time signal.* This is done by using a linear sweep voltage that sweeps upward (at each conversion interval) to an amplitude above that of the analog signal. The *time* for the sweep voltage to move from a fixed reference voltage (A) to the exact amplitude of the analog signal (B) is thus directly proportional to the analog voltage signal. This time is measured by a counting circuit, as shown in Fig. 8-4.

At the instant that the sweep begins, a *gate* is opened to allow a set of counters to fill from a clock. The counters are arranged to start the count at the instant the sweep is begun, and to stop the count when the sweep voltage intersects the arbitrary voltage being converted, at which time a pulse command is emitted to read the counters. A direct a-to-d conversion results.

This method is used in a system that converts pressures to digital readings. The sweep used is an actual pressure ramp which is continuously compared with the unknown pressure; a differential-pressure gage is used to make the comparison. During the sweep interval, counters are filling at a fixed rate. When the sweep pressure equals the unknown pressure, a valve actuates a relay which allows the count on the counters to be read.

The *resolution* of a time-encoding system depends on the number of counts made in the time of the sweep. Thus, if the clock frequency is chosen to allow 128 counts in the *full sweep time,* the resolution is 1 part in 128, whereas if 1000 counts are made the resolution is 1 part in 1000. Note also that, as the maximum number of counts in the interval is fixed, the count not only gives the amplitude of the variable being digitized but also gives the exact time at which it is being measured. This is an important point.

Additional devices, such as clamps, are used to sample the unknown at precise intervals and hold the voltage constant during the sweep interval. This assures that the readings are obtained at fixed intervals.

The *accuracy* of the conversion depends on the linearity of the sweep.

Circuits Used for Time Encoding

A *phantastron* circuit can be used to obtain the linear sweep, and a series of *flip-flops* to obtain the binary count. The point at which the sweep voltage and unknown voltage intersect can be determined by a *voltage comparator* circuit. The count on the flip-flops is read by a pulse generated by the comparator circuit when the sweep and unknown voltage intersect.

Fig. 8-5 shows a block diagram of a typical circuit. The circuit uses 7 flip-flops to achieve a maximum count of 128, corresponding to a resolution of 1 part in 128 in converting the unknown voltages to a binary digital reading. The clock, or fixed-frequency pulse generator, is either a multivibrator or a crystal-controlled oscillator. The phantastron sweep is triggered at every 256th pulse, as established by the output of the 8 flip flops marked "Time Counting" at the top of Fig. 8-5. Simultaneously, a gate is opened and the clock pulses fill the coincidence counters in the sweep interval. The unknown and sweep voltage are continously compared in the voltage comparator. When the two are equal, the comparator changes state and emits a pulse which is used to read the counters. The counters then clear themselves and await the next opening of the gate.

Note that the phantastron circuit rests for half of the time—it sweeps for an interval equal to 128 clock pulses, then rests for 128 pulses. For this reason the count must take place in half the sampling interval. The readout, or point at which the sweep and unknown voltage intersect, can occur in any part of the first half of the cycle of operation; the phantastron and counters rest for the remaining half of the operating period to allow the capacitors in the sweep circuit to regenerate. The next pulse repeats the operation. A circuit of a phantastron is shown in Fig. 8-6; that of a comparator in Fig. 8-7. The linking of the flip-flops is conventional, as is the multivibrator circuit. (Flip-flop circuits, multivibrators, etc., were described previously in Chapter 5.)

The output of the circuit of Fig. 8-5 provides *time parallel pulses.* That is, all of the bits in the digitization are presented simultaneously. These are taken off the counters on separate leads for recording or ultimate computational use.

Several encoders of this time-base-encoding type are in practical use, as will be described in the following

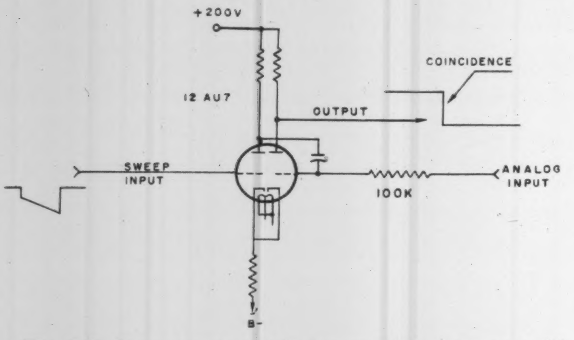

Fig. 8-7. Comparator circuit for comparing sweep voltage and analog signal input to establish the instant of equal amplitude.

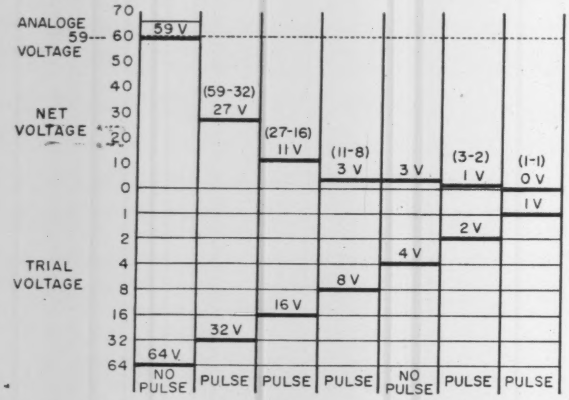

Fig. 8-8. Principle of feedback encoding. The unknown voltage (59 volts) is compared against trial voltage; difference is then compared against next lower trial voltage (whenever unknown is larger than the trial voltage). A pulse is emitted each time the difference is established. Output is unknown voltage in binary form—111011 for case of 59-v signal shown.

chapter. They suffer from a limitation in converting speed because the flip-flops are difficult to drive above 5 megacycles per second. This means that a system of 1% resolution (1 part per 100) is limited to under 10,000 conversions per second because 10,000 conversions at 100 counts each require 1,000,000 pulses in the reading interval. The accuracy is limited by the linear sweep, but generally can be made better than 0.2%. (One time-encoding converter that uses flip-flops driven at 20 Mc will be described later.)

The principal problems of time encoding are:

1. Readings at irregular intervals
2. Ambiguous readings

Readings at irregular intervals are a function of the linearity of the sweep and of the accuracy with which the start of the count (point A in Fig. 8-3) is established. A clamping device is required to establish this point accurately. Serious errors can result—even though the actual voltage is correctly read—if the *time* at which it occurred is not known exactly. As was pointed out, this time is established by the reading (a fact generally overlooked by users of this type of equipment).

The second problem is ambiguous readings, which develop from the counters changing during the readout pulse time. This can lead to random and serious errors which are not as easily overcome as in other techniques.

The basic advantages of time-base encoding are (1) simplicity of the circuitry, (2) ease of construction, (3) use of only a few basic circuits, and (4) absence of logical circuitry.

Feedback (Voltage Comparison) Encoding

The second popular method of encoding which can be operated with high resolution and accuracy is *feedback encoding*, or *voltage comparison encoding*. In this technique, trial voltages are successively compared with the unknown voltage. If the trial voltage *exceeds* the unknown voltage it is discarded. If it is *less than* the unknown voltage, it is subtracted from the unknown voltage and a pulse is emitted. If the trial voltages are successively smaller powers of 2, such as 128, 64, 32, 16, and so on, the result is a binary digitization of the unknown voltage.

The principle of feedback encoding is shown in Fig. 8-8; a fixed voltage (59 volts) is shown being converted to binary code. The fixed voltage is presumed to be unchanging during the conversion interval. (This is necessary and indicates a clamping device to fix the unknown voltage during the conversion period.)

The unknown voltage is first compared with a voltage of 64 units. This voltage exceeds the unknown voltage and is rejected; no pulse is emitted. The next trial voltage is 32, the next lower binary number. This is subtracted from the unknown voltage (59) and a pulse is emitted representing the bit 32; the residual voltage 59—32, or 27, is then compared with the third trial voltage, 16. As 16 is less than the residual 27, a pulse is emitted; the net voltage left is 27—16, or 11. The next trial voltage is 8; as it is less than 11 a pulse is emitted, leaving net 3, and so on. The pulses emitted represent binary 1; thus we receive the digitized reading of the unknown voltage in binary code. The pulses are emitted serially; this is called a *time serial output.*

Feedback encoding of this sort is limited in accuracy by the accuracy of the trial voltage and the comparator circuit. As the trial voltages must be obtained by potential dividers, the over-all accuracy depends on the accuracy and stability of a standard voltage and the dividing resistors used. The lower limit is about 0.1% at present.

The speed of this type of encoding is appreciably faster than that of time encoding; using a beam-switching tube of the magnetron type (such as the beam-switching tube shown in Fig. 8-9), the encodings can be made as fast as 100,000 a second. The resolution depends on the number of bits used; a series of seven bits tried, as in Fig. 8-8, results in a 0.78% system (1 part in 128).

The disadvantage of this technique is in the logical circuitry required to reject or subtract the trial voltages. In addition, conventional circuitry to switch the various voltages leads to a considerable number of diode matrices. The switching circuitry can be simplified by using a typical commercial ten-position beam-switching tube (Fig. 8-9). This tube acts to trigger up to ten gates to supply the trial voltages successively, stepping from one

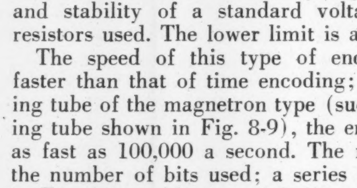
TARGET PLATE OUTPUT
CONTROL ELEMENT SWITCHING GRID
CATHODE
SPADE BEAM FORMING AND LOCKING

Fig. 8-9. Beam-switching tube.

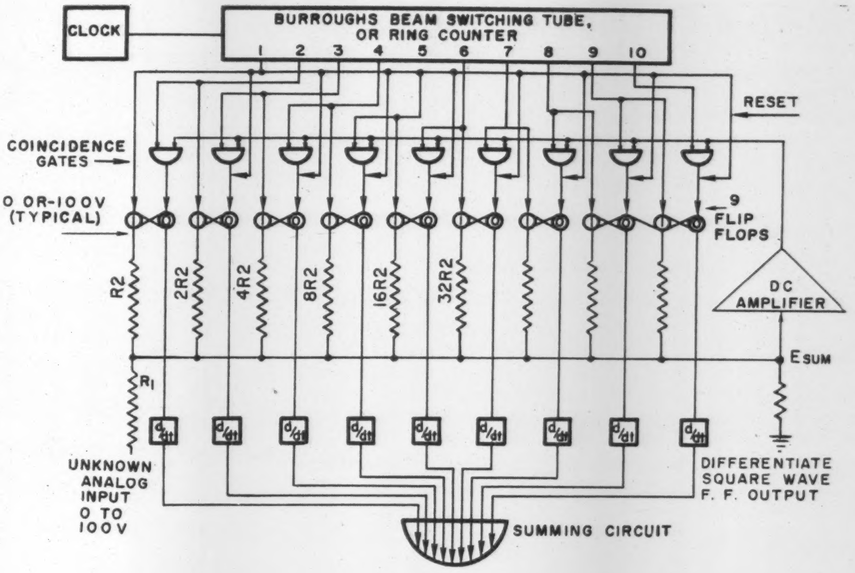

Fig. 8-10. Circuitry for feedback encoding. Resistors R1, R2, 2R2, 4R2, etc., comprise the voltage divider that develops the trial voltages. Trial voltages and unknown voltage are compared in the flip flops, which are biased by the trial voltages so that the flip flop activates only when unknown voltage (or difference voltage) exceeds the trial voltage. The beam switching tube or ring counter controls the coincidence gates that apply the unknown (or difference voltage) to each flip flop in turn.

gate to the next on each pulse received by the beam-switching tube.

A Feedback Encoding System

The comparator and summing circuits, the gating circuits, and the logical circuitry to execute the rejection or acceptance of the trial voltages are shown in Fig. 8-10. Resistors R1, R2, 2R2, 4R2, etc., comprise the voltage dividers that develop the trial voltages. The trial voltages bias flip flops that are triggered only when the unknown voltage (or difference voltage) exceeds the trial voltage. A beam-switching tube or ring counter triggers the coincidence gates. The differentiating networks of the output produce the pulses that represent the action of the flip flops. The summing circuit feeds the pulse code output of the flip flops to a single output line and also provides isolation between them.

It is necessary to clamp the unknown voltages during the interval in which the successive trials are being made. If this unknown voltage varies during the successive weightings, meaningless codings are obtained.

It is also possible to use an electromechanical device such as a stepping switch to apply the successive trial voltages. This permits extremely accurate resolutions because stepping switches of up to 100 steps are obtainable. However, the practical limit here again is the standard voltage and the potential-divider network. Furthermore, stepping switches are limited to only forty or fifty steps a second, and crossbar-type switches to about 100. Therefore, a 0.1% conversion requiring ten trials (that is, using a voltage divider of 10 steps) would limit the rate of conversion to four or five a second.

Commercial all-electronic high-speed converters using voltage-comparison techniques will be described in the following chapter.

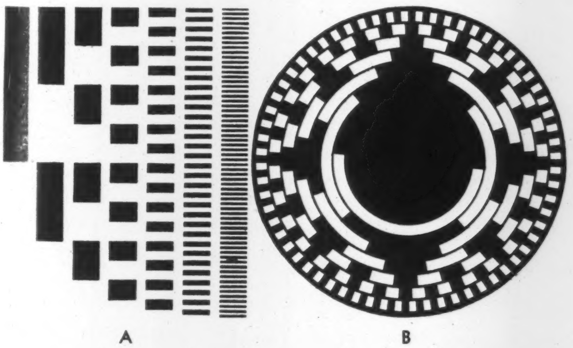

Fig. 8-11. A, Typical spatial coding mask laid out on a flat rectangular surface. B, Segment of a spatial binary coding mask laid out radially on a wheel.

Spatial Encoding

The most direct encoding method (and perhaps the most useful but least used at present) is *spatial encoding*, which uses a spatial geometric configuration. The spatial geometry can be laid out in the form of code patterns on the periphery of a wheel, patterns at fixed radial distances on a concentric set of wheels, patterns on a mask laid over a cathode-ray tube, patterns on a mask in front of a set of photocells, etc. Typical spatial coding patterns are shown in Fig. 8-11.

Where spatial-coded discs are used, the code can be developed by brushes making contact with portions of the disc, by switches actuated by hills and valleys machined on the disc, by light beams passing through transparent portions of the disc, and so forth, as will be described. It is obvious that the number of digits available in the code depends on the number of patterns that can be placed on the disc, and hence on the size of the disc. Where brushes are used, most present discs use up to 7 digits (7 layers of pattern) to provide a count of 2^7 or 128; with photoelectric technique, up to 16 digits have been placed on one wheel. To obtain higher resolutions of up to 1 million counts, it is necessary to use discs geared together via a reduction ratio. For example, a 7-pattern code wheel of 2^7 counts, geared through a 64:1 gear ratio to another code wheel of 2^7 counts, will yield a resolution of $2^7 \times 2^6$, or 2^{13} counts. However, 64 revolutions of the shaft will be required for the total count of 2^{13}.

The use of gearing raises the problem of ambiguity caused by backlash in the gears. One converter manufacturer uses redundant (extra) patterns placed on the unused patterns of the coarse encoder, and a circuit using a diode net, to eliminate possible ambiguity.

Use of double brushes, one of which straddles the area of uncertainty, is a common method for eliminating ambiguity of coded discs, with or without gearing. A relay unit selects the proper set of brushes in a logical manner.

C-R-Tube Spatial Encoder

Probably the simplest and most obvious (and incidentally the fastest) converter can be made directly from an ordinary cathode-ray oscilloscope. Suppose that the cathode-ray tube (Fig. 8-12) is covered with a mask similar to that shown in Fig. 8-11,A. This mask is a binary representation of decimal numbers from 0 to 127—that is, all numbers up to 2^7. Each vertical column represents a bit, and each vertical position reads out a binary code for the position it represents. Thus, if a black space in a column represents a 1 and a clear space a 0, reading across the bottom we obtain the number 0000000, and across the top 1111111, corresponding to decimal numbers 0 and 127, respectively.

An oscilloscope receiving a signal on the y-deflection plates displaces the beam vertically in proportion to the signal. If we arrange the maximum deflection to cause the beam to traverse at 1111111, and the minimal deflection at 0000000, we can construct an all-electronic converter by fastening the mask to the front of the tube. Each horizontal sweep of the beam presents us with a series of light pulses as the beam sweeps horizontally across the tube at a fixed vertical position (established by the voltage to be digitized). If a lens and photocell are placed in front of the tube, as shown in Fig. 8-12, we obtain a series of electrical pulses which are a binary representation of the voltage producing the y deflection. If we arrange a sweep to occur at fixed intervals of 1000 per second, we obtain 1000 analog-to-digital conversions per second.

Note that as in all the other converters it is necessary to clamp or fix the voltage during a single sweep. As in all previous cases, a varying voltage during a single sweep results in a meaningless digitization.

The resolution of this type of encoding depends on the number of discrete lines that can be developed on the tube face. This limits the resolution of a single cathode-ray tube to about 1000 divisions vertically. The accuracy of the system depends on the linearity of the vertical-deflection plates with respect to the input signal, and on the linearity of sweep of the tube. General practice here is to hold it to about 0.1% with quality circuits and tubes.

In the system shown in Fig. 8-12, the conversion speed is limited by the recovery time of the photocell and the phosphor of the C-R tube. Modern vacuum types or secondary emission photocells will respond to microsecond light flashes; gas phototubes can respond at about 10 kc; 25,000 conversions per second can be obtained with a good system at present.

An alternate technique makes use of a monoscope tube (a tube used to generate TV test patterns) in which the binary pattern is permanently photographed onto the target of the tube. The target is then permanently made part of the tube and can be used to generate the pulse train depending on the vertical height of a single tube sweep, much like the cathode-ray tube. This eliminates the photocell and permits conversions in excess of five million per second.

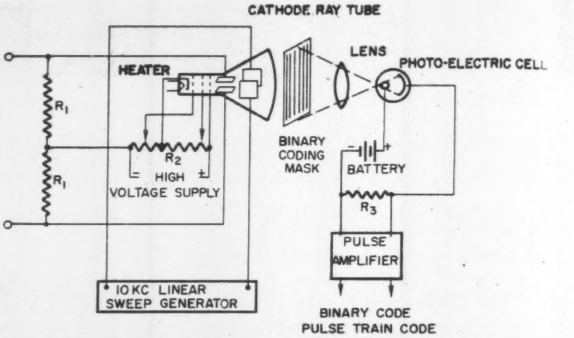

Fig. 8-12. Simple and rapid analog-to-digital converter comprises a C-R tube with rectangular spatial coding mask (as in Fig. 8-11, A) on face. When horizontal sweep is applied (at desired sampling interval), output from photocell is binary representation of the unknown voltage applied to the vertical-deflection plates. Seven-bit mask shown in Fig. 8-11, A gives resolution of 1 part in 128.

Ambiguity in Spatial Coding

Several techniques are used to eliminate *ambiguous readings* in spatial encoders that can result from horizontal traverses of the beam at some indefinite point between two markings. One of these involves a special *cyclic coding* for the mask, as shown in Fig. 8-13. Note that no matter at what position the traverse takes place, only one bit changes at a time. In conventional coding, several bits change together—for example, in going from 111 to 1000 (the next binary number), three bits change simultaneously, and if one doesn't change properly a large error can result. The cyclic codes avoid this and allow only a single bit to change in going from any number to the next. Thus, if a reading is made indefinitely between two values, it is only in error to the extent of a single bit.

The difficulty in using cyclic codings is that special circuitry must be used to go from the cyclic coding to binary. Although several ingenious circuits have been worked out this is, in general, a cumbersome way of solving the problem. The entire problem can be avoided by using a *redundant mask.*

When using a redundant mask, an extra (or redundant) column is placed on the mask in addition to the usual binary code. The traversing beam is arranged so that it passes across the mask, first reaching the redundant column, which can be either adjacent to the least-significant or most-significant bit, depending on how the readout is desired. The redundant column is arranged so that each mark is halfway between any code markings and half the width of the least-significant bit used on the mask.

If the beam traverses in such a way that it does not cross a redundancy mark, an unambiguous readout will be obtained. However, if the beam traverses "in a crack" where an indefinite reading would have been obtained, it will first strike the redundancy mark. This mark adds a fixed incremental voltage to the y input, effectively adding an error of half a bit. However, the traverse will now be a definite unambiguous reading. In other words, the redundancy mark adds a fixed incremental voltage to prevent the beam from giving an ambiguous "crack" reading. Every traverse leads to a definite coding at the expense of an error which is less than the resolution of

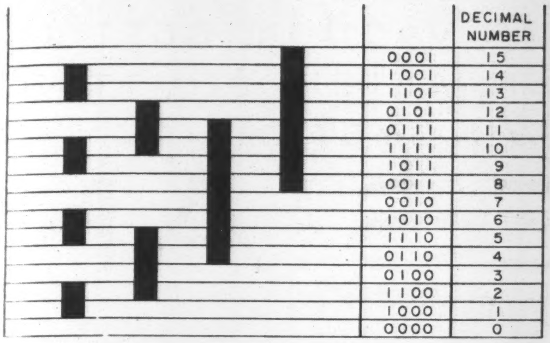

Fig. 8-13. Cyclic mask reduces ambiguity errors because code is selected so that only 1 bit changes in progressing from one number to the next. Error can thus be only 1 bit and can represent only an adjacent number. By contrast, conventional binary must change three bits in progressing from 111 to 1000, and error can indicate many different numbers.

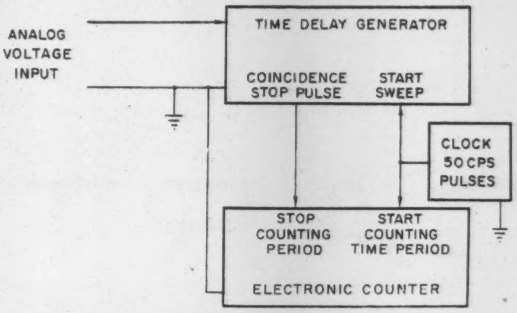

Fig. 8-14. Simple all-electronic analog-to-digital converter can be made with a commercial time-delay generator and conventional electronic counter.

the system. This obviates the need for cyclic coding and the attendant converting circuitry.

Circumventing the Clamp

As in all converters, the signal must be clamped during a single traverse of the beam because if the y deflection changes during the encoding, a meaningless coding results.

In all encoders it is possible to circumvent the use of a clamp by converting at such high speed that the incoming signal cannot change more than one bit during the conversion interval. Use of (1) a filter to limit the frequency response of the input and (2) a high conversion rate can prevent changes of more than a bit during the conversion interval and thus prevent meaningless codings. As the sweep rate of a cathode-ray-tube encoder can be made high, it is often possible to use this clamp-eliminating technique with this type of encoding.

Commercial converters using spatial-encoding techniques will be described in the following chapter.

Combined Techniques

Several techniques for encoding using combination methods have been suggested; one was actually built at Northwestern University. One method combines the advantages of time and feedback encoding by first encoding by feedback to eight bits (about the practical limit of accuracy in parts, or feedback, encoding). The residual voltage is then amplified and digitized using a time encoder. Somewhat faster speed is claimed for this system than either of the two separately.

Another technique for extending the accuracy and resolution of a cathode-ray spatial encoder is to use two encoding tubes. The signal is first encoded to the accuracy of, say, eight places (2^8, or 1 part in 256). The voltage represented by this eight-place encoding is then subtracted from the signal voltage. The balance is amplified and space encoded on a second encoding tube with a higher gain circuit, as with the first. The two encodings are thus the complete encoding to high accuracy. However, here again, the subtracted quantity rests ultimately on the ability to deliver a standard voltage to the subtraction circuit. With the best electronic parts, it is difficult to improve much beyond 0.1%.

Advantages and Disadvantages of Different Types of Encoders

The development of high-speed all-electronic encoders is fairly new. It is only within the past two years that any extensive effort has been put forth to convert analog signals to digital signals (although work along these lines began over fifteen years ago). Each of the three basic approaches mentioned offers a fertile field for future development.

Of the three, the simplest and very promising is the spatial encoder. This method offers the opportunity for the highest speeds of conversion and the simplest circuitry. Virtually no logical circuitry, matrices, or other auxiliary circuitry (aside from amplifiers and sweep circuits) are needed. The minimal-sized unit, it appears, can be developed from this type of encoder. It is also among the oldest methods of encoding electronically. By using a monoscope tube, conversion rates of ten million per second are possible with accuracies and resolution up to 0.1%. This is about the ultimate obtainable in any conversion system at present.

The time encoder, although it uses logical circuitry, is also extremely useful. It is limited in speed in inverse proportion to its resolution. With the optimal flip-flop-speed practical (about ten million pulses per second) a 0.1%-resolution system is limited to a conversion rate of about 10,000 conversions per second. The accuracy of the linear sweep used in time encoding can be made better than 0.1%, but the system is generally limited by the speed of the counters.

Of the three, feedback encoding is the least developed but most promising. It has a maximum operating speed in the immediate future of about 200,000 conversions per second, with 0.1% resolution. However, the associated circuitry is complex.

The purely mechanical converters are of passing interest. With a commercial time-delay generator and conventional electronic counter, conversions can be made all electronically at a rate that not even the best mechanical converters can approach. A simple system using these two units to provide a direct digital readout of an analog signal with 0.1% accuracy is shown in Fig. 8-14. This is essentially a slow-speed version of the time-encoding method described. The time display on the counter can be held as long as desired to permit observation of the digital numbers.

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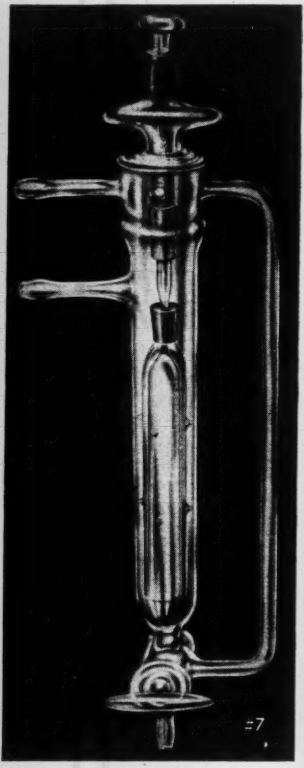
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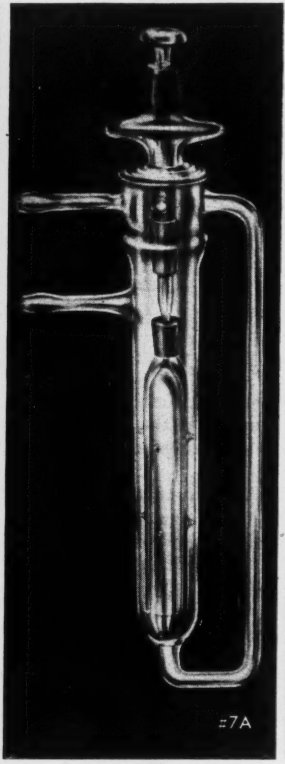
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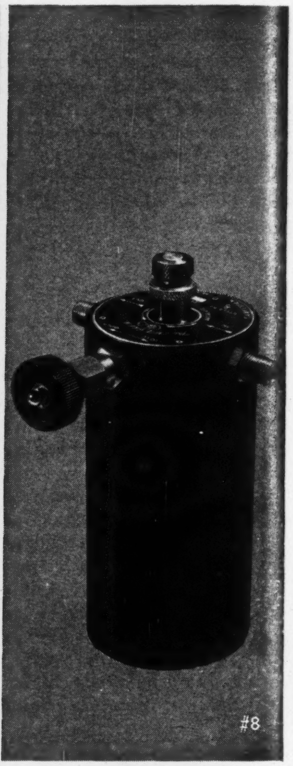
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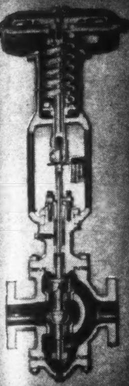

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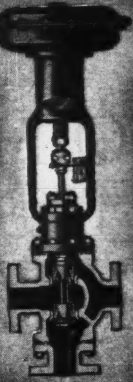

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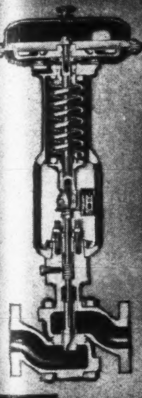

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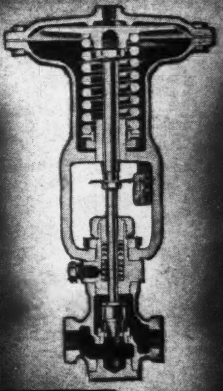

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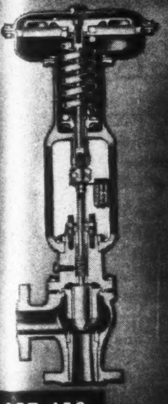

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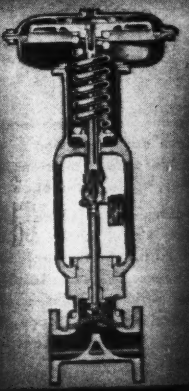

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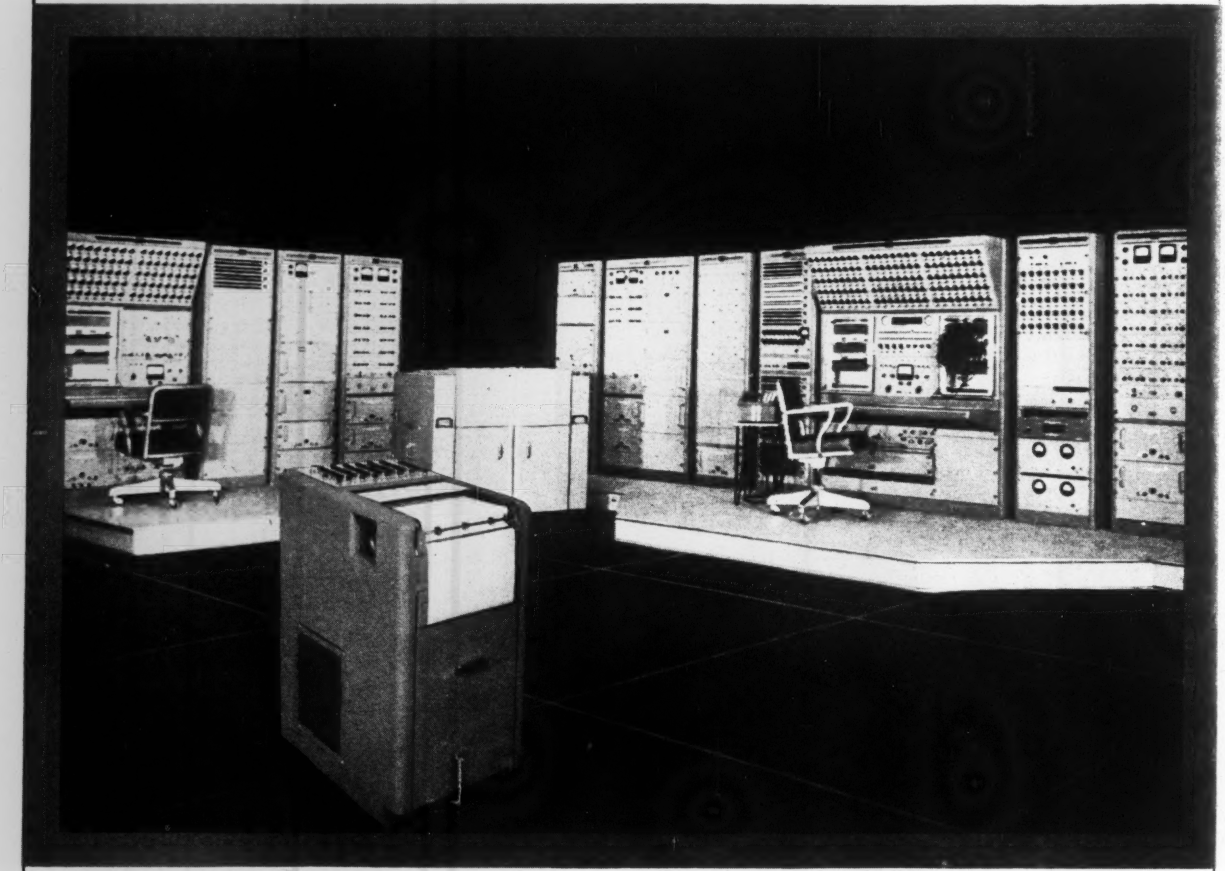

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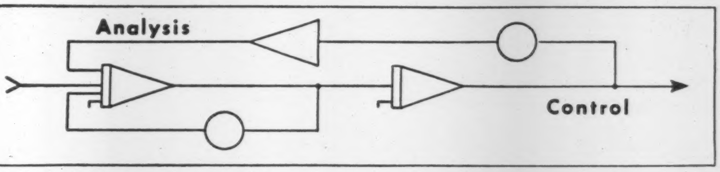

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Bits

Copying from a book is "cribbing." Copying from two or more books is "research." If you can get someone else to do the copying it becomes a "project"—or a Newsletter.

An interesting bit of information gathered from *Bill McCord's* remarks at the Firestone Western Simulation Council meeting: Because of the terrific competition for engineers, Firestone is planning to move their Missile Division engineering group "up north" to a residential area out of Los Angeles smog. They believe that the location will be quite a factor in attracting and keeping engineering talent. So do I, and judging from the marked trend so do many others. Bill didn't give me permission to say just where they were going, but it is one of the most beautiful regions along the California Coast!

Pieces

WESTERN S/C MEETING OF MARCH 8 ON ELECTROMECHANICAL VS ELECTRONIC TECHNIQUES

Forty-four representatives of 26 organizations gathered at the Firestone Tire and Rubber Company's Guided Missile Division in Los Angeles on March 8th for the Western S/C discussion of electromechanical (servo) versus electronic means for analog multiplication, function-generation, and resolution.

Bill McCord, the acting Chief Engineer, welcomed us, saying he supposed we wondered what Firestone was doing in the guided missile business.* It seems that the Jet Propulsion Laboratory at Cal Tech (Pasadena, Calif.) designed the Corporal missile, and that Douglas Aircraft Company built the prototype. Then, according to Bill, in July of 1950 Firestone was awarded what was supposed to be a strictly production contract. Firestone, Bill said, delivered the first production missile in May, 1951! JPL bowed out of the picture completely as of January of this year, and now Gilfillan is responsible for the guidance system and Firestone for all of the rest.

Experience at Firestone, as at other places, showed that it takes more engineering than just production engineering to produce a missile—even one that has been well engineered in the design stage. When it is not possible to hold production tolerances to design tolerances, something must be changed. And changing one thing affects other things. How? How much? To answer such questions Firestone is planning a simulation laboratory to take over work for which they have in the past hired outside computer time. And they have had to increase their original staff of some fifty production engineers to nearly five hundred engineers of all kinds.

Loveman on Electromechanics vs Electronics

Bill Waddell (Giannini DATEX Div., Monrovia, Calif.), our Chairman, set the stage for the technical discussion by introducing *Bernie Loveman* (Reeves Instrument Corp., New York, N. Y.)* and giving a brief biography. Bernie got his BEE from Cooper Union in '46 and went to work for Curtiss-Wright until '49. He got his MS in Math from New York University in '50 and then went to work for the Glenn L. Martin Company until he joined Reeves' Project Cyclone in '52. Now, whatever his title, Bernie seems to be Reeves' ambassador of goodwill and extoller of the virtues of REAC.

---

*We also wondered why, but Bill didn't go into that. For that matter, why are Goodyear and General in the guided-missile business? Could it be that these guys are hedging against the day that guided missiles will make rubber-tired vehicles obsolete??

*Wish I could get around to meetings of all the Simulation Councils the way Bernie does!

SIMULATION COUNCIL

OPERATION	SERVO	ELECTRONIC
Multiplication	Single-Turn Potentiometers Multiturn Potentiometers	Time Division Quarter Square Law AM-FM
Function Generation (Single Variable)	Tapped Potentiometer Cam Potentiometer Functional Potentiometer	Diodes Photoformer
Function Generation (Two or more Variables)	Tapped Potentiometer Three-Dimensional Cam (MIT) Conducting Surface (Teledeltos)	Diodes PHOSIAC
Resolution	Sine-Cosine Potentiometer Induction Resolver	Function Generators and Multipliers
Continuous Resolution	Resolver and Rate Servo Resolver and Switching Servo and Sine Wave Generator	Resolver and Electronic Switch Electronic Multiplier and Sine Wave Generator

Bernie passed out copies of a paper which had the kind of gadgets he was going to talk about listed as to their function (multiplication, function generation, or resolution) and type (servo or electronic), as shown in the table. Cost is always with us, says Bernie*, so in considering any nonlinear analog device we must weigh cost against performance as determined by (a) static accuracy, (b) dynamic accuracy, (c) flexibility, (d) reliability.

Multiplication

Bernie first considered the servomultiplier, pointing out that its static accuracy is determined by the characteristics of not one but two pots (the servo follow-up pot as well as the multiplying pot) and their mutual alignment. The dynamic accuracy is of course a function of the static accuracy plus the dynamic characteristics of the servo. Here such things as the ability of the servo to track (follow a changing signal) at low speeds, hysteresis, velocity and acceleration capabilities, frequency response, and synchronization should be considered. In considering dynamic response Bernie said that it is of interest to plot error, expressed in percentage of signal amplitude, against frequency on semi-log paper. He stressed that it should be plotted with respect to the signal amplitude, not full scale, even though this makes the multiplier look worse. Acceleration or velocity limiting might prevent the following of full-scale signals at high frequencies, which are nevertheless of interest for low-amplitude work.

McLeod asked if different amplitudes would not yield different curves, but Bernie was emphatic: "No sir, not as long as you remain in the linear region. If you get out of it your curves won't mean much anyway." He then went on to say that it is easy to test synchronization by noting the response to a step input.

Bernie next turned his attention to electronic multipliers which, he said, unlike servomultipliers are usually symmetrical devices—i.e., the response is the same for x and for y. Measuring static accuracy is not difficult, but again you should be careful to state the error as percentage of signal and not full scale. Determination of the dynamic characteristics, however, gives real trouble. We like to think in terms of frequency response, but multipliers are not linear devices. Bernie told us what they do at Reeves and said that any other ideas are welcome—with the one qualification that they must be practical. At Reeves they put in x and y, one as a constant and the other as a sine wave, and measure the error, frequency response, and phase shift. How much this means to the operator is questionable. What can he do with the info when he gets it?

Norm Irvine (Aerojet-General Corp., Azusa, Calif.) suggested that they put the same sine wave into both x and y to square it, and then analyze the frequency response. Bernie replied that they had tried this, but that the double-frequency term confused the analysis. Many methods would be nice if you could generate the correct answer for comparison. But how do you generate the answer you really want?

Hans Meissinger (Hughes Aircraft Co., Culver City, Calif.) suggested a way to get an accurate reference product with servomultipliers, where the greatest error is usually due to the dynamic response of the servo. This dynamic error can be measured by comparing the signal applied to the servo to the signal from the servo feedback pot. The difference then can be used as the servo input to a second servomultiplier to generate a correction factor to be added to the first stage product, as shown in Hans' diagram. Errors introduced by the second servo will have only a second-order effect on the corrected product.* Hans' diagram is shown on next page.

Jack Sherman (Lockheed Missile Systems Div., Van Nuys, Calif.) observed that Bernie had not mentioned noise, to which Bernard replied that he certainly should have mentioned it because noise is important and, like cost, is always with us.

This led to a discussion of how noise should be specified. Sherman suggested that it should be peak-to-peak amplitude, and Bernie added that we should also specify what components are present as these RMS values, as well as the peak amplitude, are important.

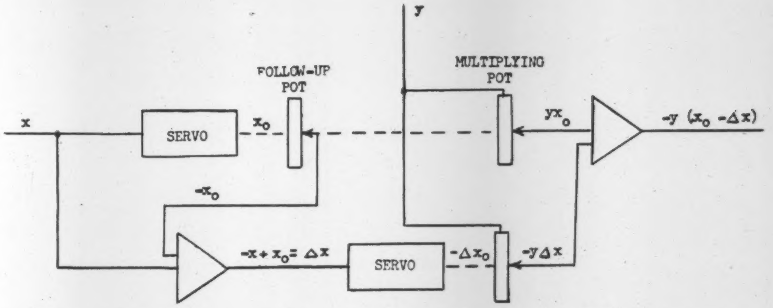
Norm Irvine, who had been mulling over the problem of testing multipliers, then returned the discussion to the idea of using the multiplier to square a sine wave. “You theoretically get a double frequency all right,” said Norm, “But it should be a good waveform. If harmonics are present does this not indicate a shortcoming of the multiplier?”

---

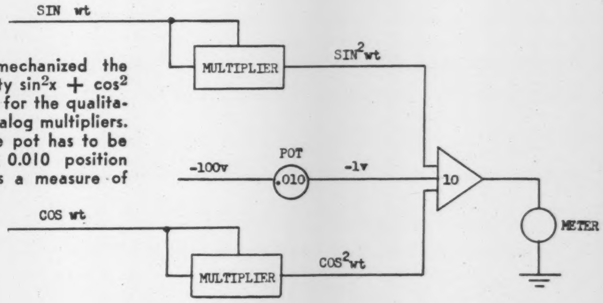
*A very cogent remark for a vendor. Some vendors like to pretend that we are all above such mundane matters as cost. They send you an elaborate brochure telling how good their product is, but not how much it costs. Your Ed has a special circular file on the floor beside his desk for all advertising literature not accompanied by a price list.

*Readers will note that this general principle, that of computing a correction to a first approximation rather than the total quantity, often can be used to ease equipment requirements and improve accuracy. For example, a missile trajectory may be approximated by a straight line, a parabola or other mathematically simple path, and only the deviations from that path computed instead of the total trajectory. This can sometimes lead to easier scaling, smaller dynamic ranges, and greater accuracy.

“Of course,” Bernie replied, “But how do you determine what the error is? You must have some way of generating a correct answer. The multiplier generates the correct answer plus some error. How do we measure that error? You might generate the double frequency with the computer or a sine-wave generator. We have tried this without success because of the synchronization problem.”



Hans Meissinger's suggestion for reducing the dynamic error of servomultipliers to a second-order effect. In effect, it compares the commanded position of the primary servo (x) with the actual position (x_o) to obtain the error Δx, and then generates and adds a correction factor yΔx to the primary product.



A. K. Seferian mechanized the trigonometric identity $\sin^2 x + \cos^2 x = 1$ in this circuit for the qualitative evaluation of analog multipliers. The amount that the pot has to be changed from the 0.010 position to null the meter is a measure of the collective error of the multipliers.

Jim Helfrich (G. S. Marshall Co., Pasadena, Calif.) inquired about plotting, which caused Bernie to ask, “How do you plot at 100 cycles? The plotter must be accurate and have good dynamic response. The most accurate are servo-driven, which precludes good dynamic response.”

McLeod suggested photographing a scope, but Bill Waddell reminded him that if you are able to read a scope to 5% you are doing well.

Everett Purcell (Douglas Aircraft Co., Long Beach, Calif.) asked, “How about using the same kind of device to multiply and then divide and compare the results with the original?” “Then how do you know where the error is?” asked Bernie. “Suppose there is no difference. How do we know that equal errors didn’t cancel? If there is a difference, how do you know where the error originated?”

Norm suggested that if the error was primarily a frequency error, it could be filtered out. Bernie asked if he meant by harmonic analyzer techniques, and said that this might be possible but that some of the error would be in amplitude.

Bernie summed up the multiplier question by saying that servomultipliers are pretty good as to accuracy if you can stand the comparatively poor dynamic response. Inaccuracies resulting from pot wear are somewhat a function of the maximum velocity. The dynamic limitations of electronic multipliers of the time-division and AM-FM variety result from the filters which are necessary on the output, and the modulation devices, whereas those of the diode quarter-square type (such as Reeves now offers) result from the capacitance of the diodes.

Function Generators

Bernie then turned to a discussion of function generators, explaining that the accuracy of tapped pots or diodes is limited by the number of segments, while the cam pot or photoformer accuracy is limited by how well the curve is reproduced by the cam or mask. Reeves’ current function generator is the diode type, which they check in terms of slopes and breakpoints (but are open to suggestions for other methods).

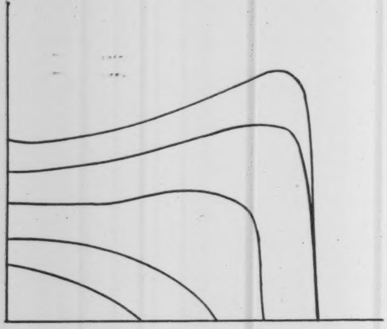
To this Bill Waddell replied that Irwin Pfeffer (Ramo-Wooldridge Corp., Los Angeles, Calif.) will be able to check all things analog for us as soon as he gets his Epsco digitalizer because he already has a good recording and analyzing device in the memory and computing capabilities of the Rem Rand 1103. Pfeffer concurred, saying that they might be able to sample as fast as 5,000 times a second, but that the 1103 couldn’t do much computation at that rate. Bill agreed but said that computation wasn’t necessary as long as it could store at that rate—the analysis can be made later.

A. K. Seferian (Rocketdyne, North American Aviation, Inc.), who had been working with a pencil and paper in the last row of seats, brought us back to the multiplier evaluation problem by suggesting that though he couldn’t tell where all the errors originated, he could suggest a way of checking one multiplier against another of possibly known characteristics. His method is indicated in the diagram shown above, wherein he introduces a sine wave into both inputs of one multiplier in phase with the introduction of the cosine into both inputs of the other multiplier. These two are added and should equal 1 according to the trigonometric identity $\sin^2 x + \cos^2 x = 1$. Therefore, subtracting 1 should leave zero. It will be noted that Seferian’s arrangement, instead of subtracting exactly 1, subtracts whatever is necessary to null the output of the summing amplifier, and thus the difference between this quantity and 1 is a measure of the error of the multipliers. If one of these multipliers was known to be good, or at least known to have a constant error, it could be left in the circuit and multipliers of unknown characteristics could be checked against it.

Bernie then proceeded to a discussion of a function of two variables, mentioning tapped pots, three-dimensional cams such as used at MIT, and conducting surfaces, such as the coated glass described by *Verne Larrowe* (Willow Run Research Center, Ypsilanti, Michigan) at the National Simulation Conference in Dallas, and the Teledeltos paper which has been discussed in the Newsletter several times. These methods are, of course, limited dynamically by the performance of their servos.

Electronic methods as suggested by Hans Meissinger and George Philbrick and the method used in PHOSIAC* can all give good results under some conditions.

Bernie then showed us two families of curves, one reasonably simple and the other, as shown in the accompanying figure, taking two channels of function generation with a total of 32 line segments and 16 amplifiers which, says Bernie, indicates that very difficult functions can be generated if you are willing to pay in terms of equipment and setup time. "It's just a question of how badly you want it."



The kind of curves that Bernie Loveman mechanized to generate a function of two variables!

Resolvers

Turning his attention to resolvers, Bernie said that there were the usual kind (operating with theta less than 360°) and those for continual rotation. The original induction-type resolver had three inputs—a, b, and θ—and produced a sin (θ), b cos (θ), a cos (θ), and b sin (θ). The equivalent pot resolver therefore must have two sine-cosine pots. The static accuracy is no problem, but the dynamic accuracy is, of course, a function of the servo response characteristics and, in the case of the induction resolvers, also of the modulation, demodulation, and filter elements.

Bernie says electronic resolvers have been proposed (GEDA?) and suggests that one might be constructed by combining an electronic function generator to produce the sine-cosine functions with an electronic multiplier, but this would make it pretty costly.

The problem of continuous rotation is inclined to crop up in a nasty sort of way, says Bernie. Of course you can drive a resolver with a rate servo, but this requires that the tachometer in the feedback loop be good enough to warrant the accuracy of the other components. As you really have an integrator, to change theta at a low rate over a relatively long period of time requires extremely high precision because of the way a small error will build up.

Another way to achieve resolution for continuous rotation is to use a regular resolver with switching, which is satisfactory if the rates are low enough. This of course could also be done at a higher rate using electronic resolver and electronic switching, but you must still watch what happens when theta dot approaches zero.

Summing up the question of servo versus electronic devices, Bernie said that, generally speaking, the electronic ones are probably more trouble and more expensive, so it might be best to stick to servos if you can.

How do you know whether you can or not? To answer this question Reeves is now offering a double-time-scale feature with their computer. A problem is set up and run in the normal manner. Then a single switch is thrown which slows the problem down by a factor of 2. It is then rerun at this lower speed and the results compared with the original run. If there are any errors resulting from the dynamic response of computer components, they can thus be detected.

Bernie said that even when you think you have scaled the problem so that you are well within the velocity and acceleration limits of your equipment, a phase error may sometimes trip you.

Helfrich asked, "By the time you use this device to discover errors isn't it a little late in the problem? Obviously where you can vary your time scale you are in good shape, but this usually comes up in connection with real-time problems."

Bernie: "Not necessarily. At Cyclone, when a digital check doesn't compare we must go back and try to find out why not. With the double-time-scale feature we can immediately eliminate the possibility of the error being the result of dynamic response. We have found this to be the difficulty in several problems where there was a choice of time scale. It was a way of determining whether an electronic multiplier is required. Trouble can sometimes be caused by a phase shift of 2 or 3/100 of a degree, even when the servo is operating well within its linear region."

McLeod asked whether it is too much of a generalization to say that if the dynamic response of your servo is satisfactory, then it is always better to use servos than electronic devices. "That depends," said Bernie, "On what electronic devices are available. Presumably everybody in the industry is working on improvements. Electronic multipliers that will be better than 1/10 volt are on their way, maybe are here. If electronic multipliers get good enough they will, of course, be preferable to servos."

McLeod: "How much do you think the psychological effect of being able to see a dial turn while you are checking out a problem is worth?"

Bernie: "Quite a bit. It is certainly comforting anyway."

Willard Uplinger (U. S. Naval Air Missile Test Center, Pt. Mugu, Calif.) asked: "Has any thought been given or any work been done to make continuous monitoring of electronic multipliers possible? A dial moving on a servo gives a pretty high level of confidence that you are obtaining multiplication."

Bernie: "I think most of the effort of industry is now devoted to improving the electronic multipliers. We will worry about indicators for monitoring later."

This led to a discussion of the negligible cost of a panel meter with respect to the cost of a channel of multiplication versus the difficulty of watching many such meters. Hans Meissinger pointed out that there is a similar problem involved in monitoring a function generator. Drift is likely to occur, so many people now check by comparing the output to a plot, which is very time-consuming.

McLeod asked Bernie if he thought the reason for all the effort now being expended by computer manufacturers on electronic components is because they feel that we have "gone about as far as we can go" with improving the performance of the servos. Bernie replied that he could not speak for all vendors, but that although Reeves has gone a long way in improving servos, there is more and more demand from customers for faster response, presumably because we are simulating things which are going faster and doing a lot of it in real time. In some cases there also may be thousands of runs to be made, so any improvement in response can mean a real saving in time.

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*See description under "Info."

Bill Waddell found it necessary at this point to call a halt to the discussion because Firestone had coffee and fancy doughnuts ready for us. When we had consumed these, Bill thanked H. I. Gibson, General Manager of the Guided Missile Division, for being our host. Mr. Gibson then gave us an introduction to the operation of the Division and divided the group up for an interesting tour of the facilities.

Information (Without Theory)

In our March *Newsletter* we gave you the word about the Simulation Council representatives at the National Conference deciding it would be a good idea to have a National Simulation Council, if only to assure that something like the National Simulation Conference would be held each year. I wanted to tell you at that time that it was also decided, subject to ratification by the individual Councils, that your Editor was chosen to be the first Chairman of the National Simulation Council. Suzy, however, insisted that it would not be couth to mention this until I had been officially notified of my endorsement by all four Councils, and to clinch her argument she tore my prepared comments on the subject out of the Newsletter manuscript and subsequently "lost" them.

Now, two months later, I am proud to announce, with Suzy's approval, that despite those things I have done to and for simulation since the formation of the Western Simulation Council in November 1952, and despite those things which I have left undone, I have gotten the signal to carry the ball for the first year of the National Simulation Council.

I am honored by the trust that even those who know me have placed in me, and I am happy that the matter of my salary has caused no dissension among the rank-and-file.

When I inquired about the duties of the position to which I have been elevated I was told that they were up to me. Imagine that! I can write my own position description as well as pay my own salary. This way I can not only give myself a raise whenever I think I deserve it, but if I get out of line I can fire myself!*

Now, before I lose any more readers, let me change from this subject so dear to my heart and give you some more interesting info culled from a letter from my friend and former colleague Dr. Otis Updike (University of Virginia, Charlottesville, Va.). Otis says in part:

"I have just learned that Don Nieman, of the Ordnance Research Lab here, has succeeded in cutting his number of diodes (in a function generator) for a simulated antenna pattern to less than half by using dither."

"J. H. Wright, of the N.B.S. (Washington) . . . thought the point we made of the logarithmic characteristic (of diodes) at the break should be even more stressed"

"Notable at the (IRE) show was computing equipment for large problems. (All vendors) seemed to be trying hard to do a good job for the people with a need for 100+ amplifiers, by offering great ease of problem setup, thorough checking, servo setting of pots from tape (or cards), etc. It looked as if there would be at least two 0.01% multipliers, (Goodyear and Beckman) by late fall—with rock-like stability expected but no hardware to show yet. Beckman shows signs of penetrating the 0.01% barrier on linear elements, though just barely as yet. In this realm, stable capacitors become a new problem!"

"You'll have Bernie's report on the ESC meeting, so I'll just add some random notes. Your letter to the National Council was well-received. . . . . I think your suggestion of New Orleans at Mardi Gras time reassured everyone that we had the right chairman!"

"The AMF capacitive function generator is intriguing, though decidedly special-purpose. With its wide dynamic range (60 db) and its high maximum slope (corresponding to over 1 Mc), its good angular resolution (1.5°), and its ruggedness and stability, it is ideal for generating simulated radar patterns and the like. By amplitude modulating the exciting oscillator, one can even multiply functions; my thought on this was that it offers a fine way to simulate glint and scintillation. With a suitable masking wheel, it might be a good generator of pseudo-random noise."

"The new function generator reported by Mid-Century may remove the interaction between breakpoint and slope settings of DFG (diode function generator) segments . . . . Let's look at it again after development has been completed. It struck me as a possible candidate for transistorization."

"A forthcoming ASME paper was mentioned: D. A. Elliott, "Representation of Non-Linear Functions of Two Input Variables on Analog Equipment," Paper No. 56IRD-11."

Otis closed with a note to Suzette concerning an idea which she conceived and Otis is "reducing to practice": a small gadget that we can fasten in our kids' pockets to radiate enough energy to help us find them if they are within the block. Otis reports: "There remains a progress report on the Son-Beacon. Diversion of personnel during the past quarter has prevented significant progress. The modification of the oscillator to increase its range is partially completed, and a mockup of a tone-modulator for signal identification has performed well. It is hoped that a prototype can be submitted for evaluation well before Mother's Day."

Can we take any advance orders?

* * *

The following is reproduced without comment because it certainly needs none!

"Dear Sir:

"I have been reading your "Stimulation" letters ever since they have appeared in *Instruments and Automation*, and although I have fallen behind in understanding them, there is one thing I am sure of. You seem to circulate around the country in the computer field. Therefore, maybe you have some influence.

"What I would like you to do is start a campaign to get all these people making computers and the like to produce their units with equal inputs and outputs. Just as everyone in the pneumatic control field, builds equipment to operate on 3 to 15 psi, so in

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*Seems to me there's a name for people who get as involved with themselves as that, but I hope you can't think of it either.

this new field the transducers should be standardized as to voltage input and output.

"Have I made myself clear? I work in a steel mill and when we ever will have one of the fruits of this new age, I do not know. But when we do, I want the components of one to work with the other or I'll become as panicky as a rooster in an empty hen-house.

"As far as I know there is about only one place where variety is nice but I cannot discuss this subject here. So will you please see what you can do to get some standardization on input and output between your computers and our industrial control equipment."

R. A. Francy
RD1, Toronto, Ohio

* * *

We have recently received the following information on PHOSIAC from the Stephen-Douglas Co., 1650 21st St., Santa Monica, Calif.

1. PHOSIAC is the final "read-out" or function-generation portion of a complete data-handling system which starts with fixed data in the form of a graphical family of curves, a table of values, or any other form of $z = f(x,y)$.
2. The three-dimensional data are transferred to a multi-channel punch tape for intermediate storage and is later fed into a data film exposure unit. The data are stored in the form of density of a photographic film. The film then is developed and reduced and becomes the fixed storage in usable form of $z = f(x,y)$, which the PHOSIAC reads out as an analog voltage by passing a beam of light through the film at it's x and y ordinates and reading the stored film density by measuring light intensities.
3. The system shall include the following units:
   (a) Automatic curve tracer and tape preparer
   (b) "Read-In" or film exposure unit
   (c) Film developer
   (d) Film reduction unit
   (e) Film packaging tool
   (f) PHOSIAC Read-Out
4. All six of the above units ("a" through "f") will be available as purchaseable items. However, the techniques involved in processing data through units "a" through "e" above are such that the Stephen-Douglas Co., Inc. will provide a data-processing service from graphical curves furnished to PHOSIAC film plates. This service will require approximately six hours for complete processing.
5. The PHOSIAC function-generation system is at present in the evaluation stage of a two-year research phase of a development program. Final evaluation of the research unit shall be completed during the latter part of June 1956. The phase-two transition (from research through production design to an "off-the-shelf" system) has already been initiated and the expected completion date is November 1956.
6. Customer requirements are being discussed at this time and tentative orders are being programmed. Until completion of the above evaluation program, performance guarantees cannot be made. However, the following performance characteristics and other pertinent facts are expected to be confirmed in detail, with absolute figures by September of this year:
   (a) *Compatability with other computers*—PHOSIAC may operate with any computing system which provides input voltages in proportion to the "x" and "y" independent variables over a range of ± 50 volts D.C., and which can receive an output voltage proportional to the "z" dependent variable over a range of ± 50 volts D.C.
   (b) *Accuracy*—consistent with that normally associated with D.C. analog computation.
   (c) *Resolution*—better than 1%
   (d) *Time Constant*—less than .01 second.
   (e) *Repeatability*—within 1%.
   (f) *Stability of Plates*—Due to the standard "base," or gray scale, which is placed on each film next to the stored data, stability of the data is kept constant in relation to the "base" through the film processing system and for long periods of storage or aging of the film.

* * *

Panhandle Pete's "Blue Monday" described in the March *I&A* reminded Suzy of some of our more "interesting" trips into the wilds of Baja California where you can tell the tequila is genuine 'cause you can taste the cactus spines. We lost our car once too—but we were in it!

He Went Thataway

John McLeod to Convair, San Diego.

(A new department of the N/L. Please send us any info you have on job changes of our friends.)

Thot

'Tis human to err, but errors in our defense effort can be disastrous. Let us then make our errors on computers—quickly, economically, and harmlessly.

Computer Events

Other events on page 828

Eastern Simulation Council

Date: 21 May 1956
Time: 11 A.M. to 5 P.M. (E.D.T.)
Place: East Bldg. Lecture Room, National Bureau of Standards, Washington 25, D. C.
Subject: Analog-to-Digital Conversion. A visit to the NBS analog facility and the digital computer facility SEAC is arranged for 10 A.M., in the Computer Laboratory.
Speakers: L. Taback (NBS); B. M. Gordon (Epsco); P. A. Hurney (Hycon Eastern); A. R. Baechtel (ACF Electronics); B. D. Smith (Melpar).

Midwestern Simulation Council

Date: Monday, 9 July 1956
Place: Detroit Tank Arsenal Centerline (Detroit), Mich.

Western Simulation Council

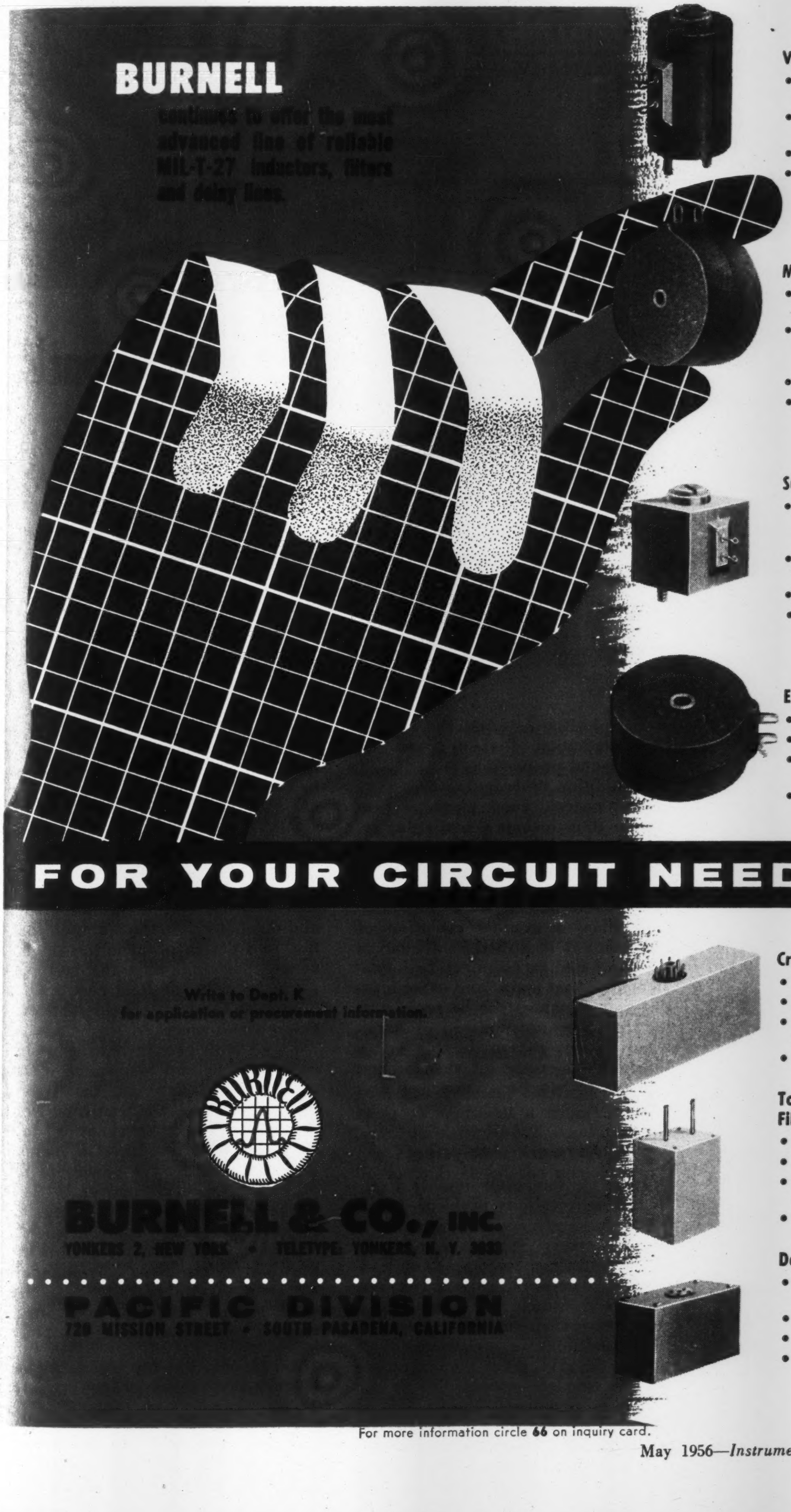
Date: Thursday, 12 July 1956 (tentative)
Time: 1:00 PM
Place: Convair, San Diego, Calif.
Subject: "Combined Analog and Digital Simulation" Confidential security clearance will be required. The man to see is Stan Rogers, Building 51, Plant 1.

WESCON

Dates: 21-24 August 1956
Place: Los Angeles, Calif. For information write to WESCON, 344 N. La Brea, Los Angeles 36, Calif.

Association for Computing Machinery

Dates: 27-29 August 1956
Place: University of California at Los Angeles, Los Angeles, Cal.
Subject: 11th Annual Meeting Correspondence concerning arrangements should be sent to ACM, Box 3251, Olympic Station, Beverly Hills, Calif.



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The McIlroy Pipeline Network

Good planning of a pipeline network requires continuous reappraisal of present and future requirements for expansion, new loads, capacity under emergency conditions, etc. This formidable analysis becomes practical by use of the McIlroy Network Analyzer, a direct-reading nonlinear analog computer.

H. M. BOYER
Southern California Gas Co

DISTRIBUTION PIPELINE SYSTEMS have expanded rapidly during the post-war decade, and their increasing complexities point up the need for intensive planning, while at the same time making a rational approach to good design more difficult.

Variables in the System Design

There are a number of variables which influence the ultimate configuration of a piping system, such as location and magnitude of present demand requirements, hourly, daily and seasonal load characteristics, predicted load increases over a number of years, size and location of new principal supply lines, provision for future augmentation of principal supply line capacity, and location and capacity of sources. When the interaction of these variables is compounded by the sheer physical size of the pipeline network, the task of the distribution designer assumes monumental proportions.

In addition to designing new parts of the system, good planning procedures must include a continuing reappraisal of the capabilities of present facilities. Shifting of load centers and changes in peak load characteristics should be detected in this manner. When a gradual evolution of conditions is identified as a trend, a broadly based redesign can be implemented so that mains and other pipeline appurtenances can be re-sized at the time they are replaced or parallelled for any reason. In this way a forecasted increase of demand requirements can be approached progressively.

June Meeting: *Thursday, the 21st, Rio Hondo Country Club, Downey, Calif.*

Feature: *Earle Pitt, Foxboro Company, will present a talk entitled "Modern Concepts of Measurement."*

Network Analysis

From the foregoing simplified version of deliverability problems which confront the planner of an expanding pipeline system, it is clear that reliable answers can be obtained only by exhaustive network analysis. Network analysis is usually taken to mean a complete evaluation of pressure and flow conditions in each segment of pipe in the grid. When the magnitude of the problem exceeds 30 to 40 loops, the engineer equipped only with a slide rule and a furrowed brow is all but overwhelmed by the mass of calculations required. To make a bad situation worse, the investigation of several alternative solutions involves complete recomputation for each trial. As a matter of practical necessity the number of possibilities which can be studied is sharply limited from consideration of time and manpower. As the optimum solution to a design problem has the advantage of combining the best performance with the least cost, such a limitation can have considerable economic significance.

Faced with ever-increasing design complications and inadequate means to meet the challenge, the system planner welcomes the transition from "engineering by approximation" to a more classical and precise method made possible by the advent of the McIlroy Network Analyzer*. This equipment utilizes the principles of the electrical-fluid analogy wherein electrical variables in d-c circuitry are used to represent corresponding variables in fluid-carrying pipelines. It is properly defined as a direct-reading nonlinear analog computer.

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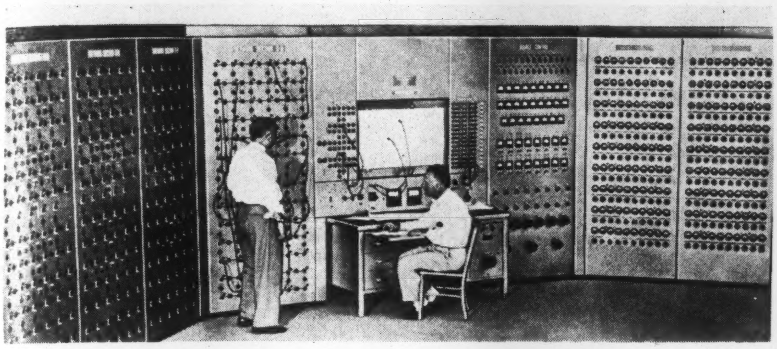
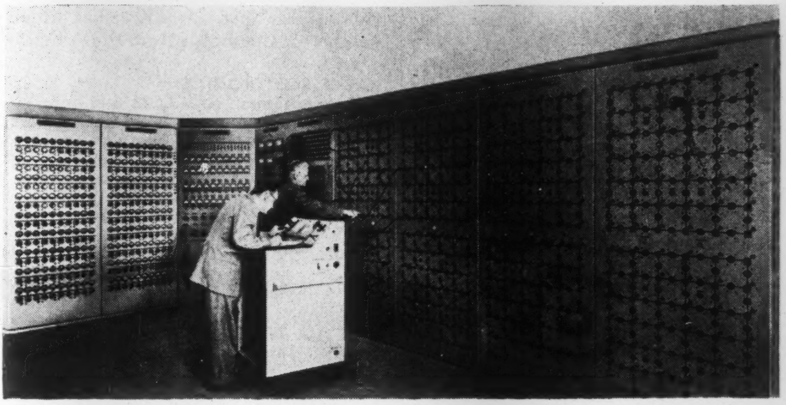
*Manufactured by the Standard Electric Time Company, Springfield, Mass.



McIlroy Fluid Network Analyzer for The Ohio Fuel Gas Company, operated by the Columbia Gas Systems Service Corporation.

Analyzer



McIlroy Fluid Network Analyzer for Public Service Electric and Gas Co., Newark, N. J.

Principles of the McIlroy Analyzer

The ideal electrical-fluid analogy presumes that the mathematical expressions for flow of direct electrical current and flow of fluid have a proportional relationship so that flow rate of the fluid can be directly equated to amperes of current, and pressure drop or head loss can be equated to voltage drop. Normally, this ideal state cannot be attained because Ohm's Law is a linear expression whereas all fluid flow laws are nonlinear.

To illustrate this, compare flow terms I and Q in the generalized electrical and fluid expressions:

Electrical: $E = RI$

Flow: $Z = AK_pQ^n$

However, if a special type of resistance having a nonlinear characteristic can be substituted for R, the electrical equation $E = RI^n$ results. This modified form of Ohm's Law is compatible with the generalized fluid flow expression, and direct proportionalities between electrical and fluid flows can be established mathematically.

Special nonlinear resistances called Fluistors* are used in the McIlroy Analyzer so that the circuits operate according to the equation $E = RI^{1.85}$ (1.85 is exactly the same as the exponent of Q in several high-pressure gas-flow formulae). When the square-law equations are used, as for example with non-compressible fluids, mathematical corrections can be made to adjust them to a 1.85 exponential curve.

Setting Up a Problem

To set up a problem for analysis, the pipeline system is reproduced schematically on the internally wired network panels of the Analyzer, with each pipe section represented by a Fluistor. These are manufactured with 180 different coefficient values so as to represent a wide range of pipe diameter-length combinations. (A Fluistor coefficient is proportional to L/D^n of the pipe it represents, where n varies depending on the flow equation being used.) Loads and sources are represented electrically by withdrawing and introducing, respectively, measured amounts of current at appropriate points in the network.

The maximum scale of a single analysis is limited only by the size of the equipment. The Analyzer being installed by the Southern California Gas Company will handle 500 pipe sections, 225 loads and 36 sources simultaneously. It is safe to say that no one has ever attempted a complete analysis of this magnitude with hand computers. To furnish a basis of comparison, a problem of 50 pipe sections with several loads and sources may require 200 to 300 manhours with a slide-rule-type computer. The McIlroy Analyzer will solve the same problem with the expenditure of 25 to 30 manhours, including programing and set-up time.

In summary, the network analyzer has these practical applications:

1. Planning for expansion by developing optimum designs for new areas.
2. Determination of the effect of new loads on the existing pipe network.
3. Redesign of existing system to provide for incremental increases of deliverability as load conditions change.
4. Analysis of operational problems such as the effect of emergency re-routing of flows, line breaks, temporary shut-down, unusual peak loads, etc.

Such network analyzers not only reduce the drudgery involved with even the simplest of distribution studies, but open a whole new vista of engineering predictions previously unobtainable.

---

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INSTRUMENTS and AUTOMATION Films

WHEN the publisher of *Instruments & Automation* was executive secretary of the ISA, he prepared a list of motion picture films of interest to groups in the field of instrumentation. The following list of films can be considered a supplement to this original list. Lists of other films can be obtained also from the ASME.

BASIC ELECTRONICS
Color, 16mm., sound, 22 min.
Review: This Walt Disney production presents this complex subject reduced to simple terms.
Source: Minneapolis-Honeywell, The Tower Press Bldg., 1900 Superior Avenue, Cleveland 14, Ohio
Avail: Loan, pay return transportation cost, allow 2 weeks notice.

THE AIR WE BREATHE
B&W, 16mm., sound, 26 min.
Review: This film is a professional coverage of respirator protection for the worker against dusts, gases and other air contaminants.
Source: Advertising Manager, Mine Safety Appliances Co., Braddock, Thomas and Meade Streets, Pittsburgh 8, Pa.
Avail: Loan, pay return transportation cost, indicate a choice of dates.

YOU BET YOUR LIFE
B&W, 16mm., sound, 25 min.
Review: This film demonstrates fire-fighting masks.
Source: Advertising Manager, Mine Safety Appliances Co., Braddock, Thomas and Meade Streets, Pittsburgh 8, Pa.
Avail: Loan, pay return transportation cost, indicate a choice of dates.

TOOLS OF ABUNDANCE
Color, sound, 16mm., 28 min.
Review: This is a case history story of the basic functions of a plant production team.
Source: Wesson Co., 1220 Woodward Heights Blvd., Ferndale 20, Mich.
Avail: Loan

GLASS, SCIENCE AND PEOPLE
Color, 16mm., sound, 20 min.
Review: This film contains information of interest to graduate scientists, students, and the scientific community.
Source: Scientific Division, Kimble Glass Co., P. O. Box 1035, Toledo 1, Ohio
Avail: Loan, pay return transportation charges, report showings and attendance.

CAUTION-EYES AT WORK
Color, 16mm., sound, 20 min.
Review: The story of safety optical glass from refraction to despensing.
Source: Safety Division, American Optical Co., Southbridge, Mass.
Avail: Loan, pay transportation charges.

ETHER FOR ANESTHESIA
B&W, 16mm., sound, 21 min.
Review: The film documents scientific advancement in manufacture, purification and preservation of ether since 1846.
Source: Advertising Department, Mallinckrodt Chemical Works, 3600 North Second St., St. Louis 7, Missouri.
Avail: Loan, pay return transportation charges, allow three weeks notice.

INFORMATION AT WORK
Color, 16mm., sound, 30 min.
Review: This film is an educational and entertaining view of the entire field of instrument design, manufacture and application.
Source: W. H. Corwin, Public Relations Director, Taylor Instrument Cos., 95 Ames Street, Rochester 1, N. Y.
Avail: Loan, pay return transportation charges.

IT'S ONLY THE BEGINNING
Color, 16mm., sound, 10 min.
Review: This film tells the story of scientific research and its contribution to the progress of America.
Source: Director of Public Information, Scientific Apparatus Makers Ass'n., 20 N. Wacker Drive., Rm. 3120, Chicago 6, Ill.
Avail: Loan, pay return transportation charges.

THE COMPOUND MICROSCOPE
Color, 16mm., sound, 20 min.
Review: Animated color drawings show basic optical principles of the microscope.
Source: Film Distribution Service, Bausch & Lomb Optical Co., Rochester 2, N. Y.
Avail: Loan, report showings and attendance, pay return transportation charges.

TO GREATER VISION
B&W, 16mm., sound, 28 min.
Review: Tells the story of light and glass and the importance of optical science in our everyday life.
Source: Film Distribution Service, Bausch & Lomb Optical Co., Rochester 2, N. Y.
Avail: Loan, report showings and attendance, pay return transportation charges.

25,000,000 CYCLES*

Skinner solenoid valves are ideally suited for use in high-speed production lines. They perform lubricating, cylinder control, blowing and ejecting functions in hundreds of applications, such as drilling stamping, pressing and riveting. Skinner valves provide fast, dependable and trouble-free operation. They're leakproof, rugged, and *simple to inspect*. Available in more than 100,000 variations, so you're sure of finding the valve that is perfect for *your* particular application.

V9 Four-Way

V5 Universal

Call in a Skinner engineer *first* to help you with your solenoid valve problem. With us, no problem is too great, no quantity is too small. Write for Skinner's new solenoid valve catalog . . . on your letterhead, please.

*Special Skinner solenoid valves have proven operable up to 25,000,000 cycles in specific applications.

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SKINNER ELECTRIC VALVE DIVISION • SKINNER CHUCK COMPANY

SOLENOID VALVES

THE CREST OF QUALITY

116 Edgewood Avenue
New Britain, Conn.

WORLD-WIDE REPRESENTATION

For more information circle **68** on inquiry card.

SEND FOR T-54
TEMPERATURE MEASUREMENT and CONTROL BROCHURE

RdF STIKON®

RESISTANCE THERMOMETER ELEMENTS

Eliminate Effect of Ambient Air Temperatures

ACTUAL SIZE

Highly-stable RdF Stikons respond to changing temperatures quickly and accurately (to one-half a degree centigrade). Because of the element's thin construction (.005 to .010 inches), and the extremely close proximity of its temperature-sensitive grid to the measured surface, the effect of ambient air temperature is practically nil. When used in a bridge, *an RdF Stikon may easily produce output voltages several hundred times higher than the output of the most sensitive thermocouples.*

SUMMARY OF CHARACTERISTICS

Type	Resistance at 70°F (ohms)	Temperature Range F*
BN-1	81.7	—100° to +300°
BN-3	50.	—100° to +300°
BN-4	200.	—100° to +300°
PN-1	50.	—100° to +180°
PN-2	200.	—100° to +180°
SN-1	100.	—100° to +500°

* For continuous operation — may be used intermittently at higher temperatures. See RdF Stikon Brochure T-54.

Type	Wafer Material	Size (inches)
BN-1	Bakelite	½ x 1½ x .005
BN-3	Bakelite	5/16 x ¾ x .006
BN-4	Bakelite	9/16 x ⅞ x .006
PN-1	Paper	5/16 x ¾ x .006
PN-2	Paper	9/16 x ⅞ x .006
SN-1	Silicon-Glass	9/16 x 1 7/16 x .010

Types BN-1, BN-3 and PN-1 are marked to 0.2 ohms, while types BN-4, PN-2 and SN-1 are marked to 0.5 ohms.

Arthur C. Ruge Associates, Inc.
733 CONCORD AVE
CAMBRIDGE 38, MASS

For more information circle 69 on inquiry card.

INSTRUMENTS and AUTOMATION Books

Servomechanisms and Regulating System Design, by Harold Chestnut and Robert W. Mayer. v. 2. 1955. John Wiley and Sons, New York 16, N. Y. 384 p. $8.50. 9¼ in. Reviews some of the material in volume 1, but is for more advanced users.

Obtaining and Interpreting Test Scope Traces, by John F. Rider. [c1954.] John F. Rider, New York 13, N. Y. 186 p., unbound. $2.40. 8½ in. Deals with the cathode-ray oscilloscope, including only those details which relate to field and manufacturing applications in the maintenance and production of electronic equipment.

Index to the Literature on Spectrochemical Analysis, pt. 3, 1946-1950, by Bourdon F. Scribner and William F. Meggers. c1954. American Society for Testing Materials, Philadelphia 3, Pa. 226 p., unbound. $4.50. 9 in. (Special Technical Publication No. 41-C.) Includes 1246 references to literature in various languages, with excellent abstracts. Of these, 92 are to literature of 1941-1945 supplementing pt. 1-2. Author and subject indexes.

Switching Relay Design, by R. L. Peek, Jr., and H. N. Wagar. [c1955.] D. Van Nostrand Co., Princeton, N. J. 478 p. $9.50. 9¼ in. Based on courses in design of relays at Bell Telephone Laboratories.

Instruments for Measurement and Control, by Werner G. Holzbock. 1955. Reinhold Publishing Corp., New York 22, N. Y. 371 p. $10. 9 in. Concerned with instruments used for remote reading or remote automatic action in industrial plants. Discusses operational characteristics and also describes structural details of certain typical instruments.

Crystal Oscillators, edited by Alexander Schure. [c1955.] John F. Rider, New York 13, N. Y. 64 p., unbound. $1.25. 8½ in. Discusses nature of the piezo-electric field and the characteristics of crystal elements, and analyzes oscillator principles. Shows illustrative circuits chosen for their simplicity and relative importance.

Guide Du Controle Industriel. Published by Editions B.P.I., 79 Avenue des Champs Elysees, Paris 8e. France, 1955. Cloth, 5½ x 8¾ inches, 500 pages. Price 2450 francs (about $7) plus overseas postage on 26 ounces. This is the first printing of what probably is the world's most elaborate who-makes-what catalog and directory. Includes list of government establishments, societies. section on standards; alphabetical index of instruments and trade names; alphabetical descriptive catalog of all French manufacturers; ditto for foreign manufacturers represented in France.

Digital Differential Analyzers, by George F. Forbes. c1955. Author. Pacoima, Calif. 48 + [7] p. unbound. $7.50. 11 in. In two parts concerned, respectively, with "elements" and "applications". Presupposes some knowledge of calculus and differential equations. Reproduced from typewritten copy.

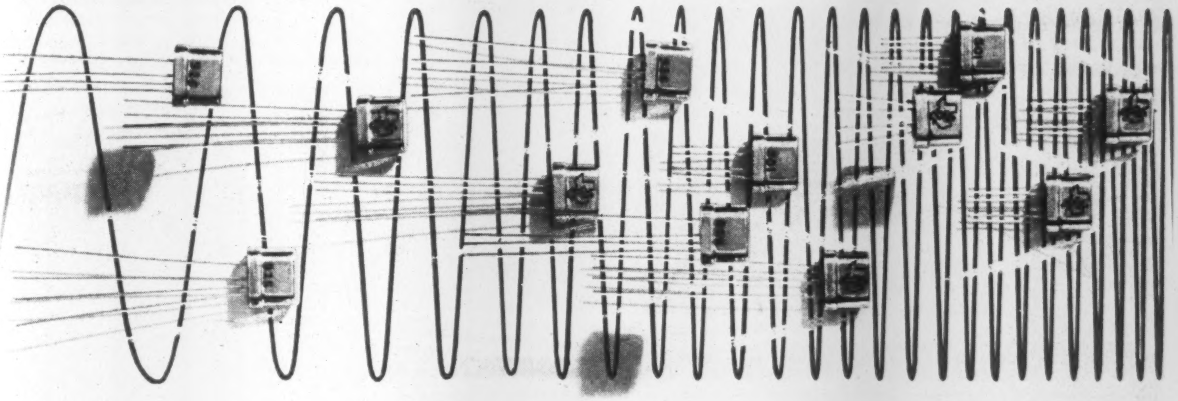
A Palimpsest on the Electronic Analog Art, edited by H. M. Paynter. 1955. George A. Philbrick Researches, Boston, Mass. 270 p., unbound. $1. 11 in. When the original inscription is erased from a parchment or other surface, thus permitting other writing, the product is known as a palimpsest. This volume is a reprint of some 35 papers, some of which have never appeared previously in print.

Particle Size Determination, by R. D. Cadle. 1955. Interscience Publishers, New York 1, N. Y. 303 p. $5.50. 7¼ in. A brief guide for the scientist or engineer. Gives considerable attention to criteria for selection of proper method from the large number available.

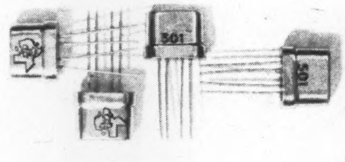
Minds and Machines, by W. Sluckin. [1954.] Penguin Books, Baltimore 11, Md. 223 p. 2s. 6d. 7 in. Author is both an engineer and a psychologist. He describes modern computing machines, points out some similarities to the nervous system. and discusses control and communication.

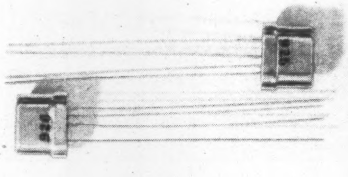
TEXAS INSTRUMENTS PROGRESS REPORT ON HIGH FREQUENCY

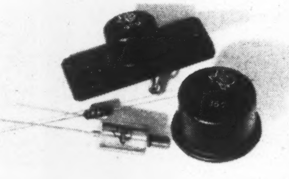
VHF transistors NOW!



NEW 'GROWN-DIFFUSED' TYPES COMMERCIALLY AVAILABLE IN PRODUCTION QUANTITIES







HIGH GAIN VHF TRANSISTORS with usable power levels and band widths are now immediately available from Texas Instruments . . . another first for the leading producer of silicon and germanium transistors. Your design horizons are now extended to include all-transistor TV, FM, and VHF receivers . . . and transistorized amplifier, oscillator, or switching applications in communications, telemetering, or radar.

NEW VHF GERMANIUM TRANSISTOR

OSCILLATING FREQUENCY IS ABOVE 250 MEGACYCLES . . . alpha cutoff frequency is 200 mc. Typical gain is 12 db at 100 mc (unregenerative). This performance in a production transistor was unheard of prior to perfection of the "grown-diffused" method — an exclusive Texas Instruments technique.

NEW HF SILICON TRANSISTORS

FREQUENCIES TO 30 MEGACYCLES, rated 30 volts and 125° C, make these "grown-diffused" units ideal for high temperature military and commercial applications. They increase to 10 the types of silicon transistors now available from Texas Instruments, and represent the continual improvement in frequency, gain, and power made by the pioneer producer of silicon transistors.

OTHER NEW SEMICONDUCTOR DEVICES FROM TI

NEW HIGH POWER TRANSISTORS — 12-watt dissipation germanium power transistor and 8.75-watt dissipation silicon power transistor. NEW HIGH VOLTAGE RECTIFIERS — full wave and single junction half wave 1500-volt silicon units stable to 150° C. NEW HIGH CONDUCTANCE DIODES — 4 types of axial-lead silicon junction diodes with 100 ma forward currents and 0.1 μa back currents.

All these devices in production and available immediately. Write today!

LOOK TO TI FOR: GERMANIUM VHF, POWER, RADIO, & GENERAL PURPOSE TRANSISTORS ● SILICON HF, POWER, & SMALL SIGNAL TRANSISTORS ● SILICON RECTIFIERS AND DIODES

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle **70** on inquiry card.

INSTRUMENTS and AUTOMATION New Instruments

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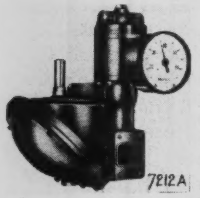
PROCESS MEASUREMENT and CONTROL

ABSOLUTE PRESSURE PNEUMATIC TRANSMITTER


7212A

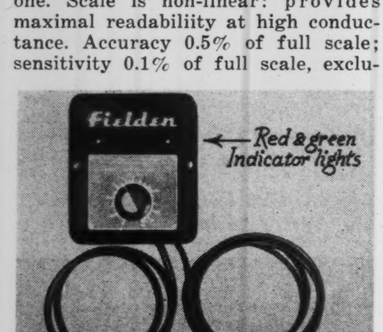
New "Metagraphic" absolute pressure transmitter measures pressures in ranges from 0-5 mm Hg abs to 0-760 mm Hg abs and transmits measurements as a universal 3-15-psi pneumatic signal to an automatic controller or receiver; can be used with any standard pneumatic receiver or automatic controller.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **301** on inquiry card.

CONDUCTIVITY CONTROLLER

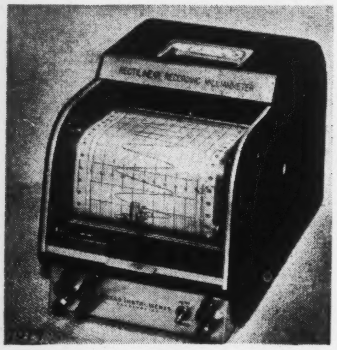
New low-cost solution conductivity controller has two-zone action for alarm or control; is available in two standard ranges: 0-to-30 or 20-to-200 micromhos/cm^3, for use with conductivity cells having a constant of one. Scale is non-linear: provides maximal readability at high conductance. Accuracy 0.5% of full scale; sensitivity 0.1% of full scale, exclusive of cell and temperature compensator. An automatic compensator minimizes solution-temperature errors. Fail-safe feature indicates "high" upon failure of a vacuum tube, power supply, shorted cell, etc. —*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

For more information circle **302** on inquiry card.



RECTILINEAR RECORDING MILLIAMMETER

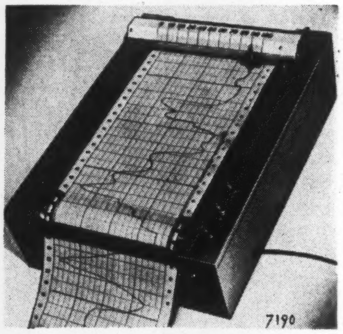
New rectilinear recording milliammeter—first of its type to be commercially available—is a ruggedized ink-writing galvanometer-actuated instrument, with front access for all routine operations. New exclusive convenience features include: front-located signal terminals (rear terminals optional), "writing desk" area on chart for notations, disappearing sliding door, front-filling inking system enclosed to prevent spilling, accessibility to perform all routine maintenance and adjustment procedures without removing case or disassembly, and fingertip changing of chart speeds.—*Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas.*



For more information circle **303** on inquiry card.

RECTILINEAR RECORDING POTENTIOMETER

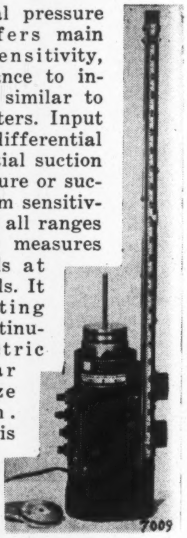
New "No. 22700" portable (15-lb) self-balancing potentiometric recorder, for speed, flow, pressure, motion, conductivity, and other process variables, features 5" pen travel across rectilinear chart, 100-mv full-scale range, high stability, high-torque pen-driving servomotor, synchronous-motor and mounting, and "very low cost plus many additional characteristics found only in recorders costing two or three times as much."—*C. H. Stoelting Co., 424 N. Homan Ave., Chicago 24, Ill.*



For more information circle **304** on inquiry card.

DIFFERENTIAL PRESSURE ELECTRICAL TRANSMITTER

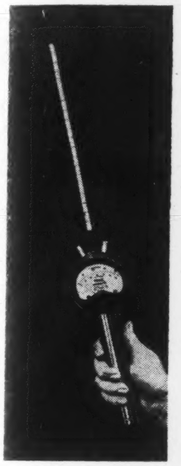
New differential pressure transmitter offers main characteristics (sensitivity, range and resistance to internal pressures) similar to dead weight testers. Input signals can be differential pressure, differential suction and straight pressure or suction. It has uniform sensitivity (0.031 psi) for all ranges of pressures and measures small differentials at high pressure levels. It comprises a floating piston rotated continuously by an electric motor and gear drive to minimize axial friction. Weight of piston is balanced by a mercury column, null point being near mid-point of mercury tube. A 240" scale, looped around a system of rollers, is located so that about 28" is visible. Scale can be moved manually or electrically. Movement of pis-



ton displaces mercury in manometer tube. Gage is so calibrated that a differential pressure of 1 psi moves piston 0.05", thereby displacing mercury column 1". With scale zero set opposite mercury-column zero, differential pressures within range of 0 to 14.7 psi vacuum and 0 to 15 psig can be read directly. For higher differential pressures, weights marked to 10 psi, 20 psia, etc., are added to piston upper shaft. A carbon brush attached to piston upper shaft varies a resistance and hence the voltage signal to a receiving instrument.—*Manning, Maxwell & Moore, Inc., Shelter Rock Lane, Danbury, Conn.*

For more information circle **305** on inquiry card.

HAND PYROMETER

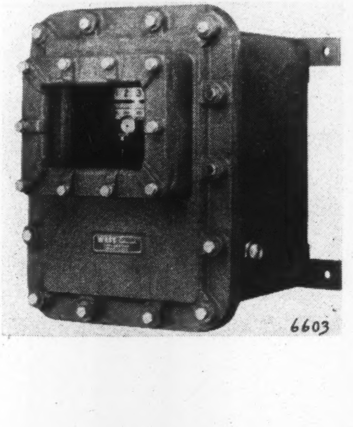


New "Model 321," for use in non-corrosive metallic and non-metallic liquids, and in atmospheres of furnaces, etc., features lightness and ruggedness; also calibrating thermometer near cold junction. Couples are refractory bead insulated, closed end type. Two types: C-A, range to 2300°F (1300°C); and I-C, range to 1600°F (800°C). D'Arsonval movement has 2.66" scale length and an easy adjustment screw for cold junction temperature.—*Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.*

For more information circle **306** on inquiry card.

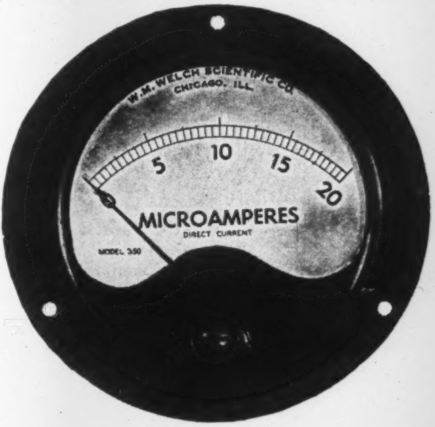
EXPLOSION-PROOF HOUSINGS FOR CONTROL PYROMETERS

New standard explosion-proof housing is available for maker's "Models J, JP and JS" automatic-control pyrometers; meets U. L. specs for Class 1 Group D hazardous locations. Block of clear safety glass, ¼" thick and 4" x 6", permits constant view of



SENSITIVE 20 MICROAMPERES MOVEMENT

Welch D. C. PANEL METERS



MODEL NO. 350

Welch Model 350 Panel Meters are often used in temporary "bread-board" assemblies and in "homemade" devices so common in electronics laboratories. In such work it is frequently more convenient to have an attached rather than a separate meter.

Suitable for such applications as measuring grid currents and currents from photoelectric tubes and cells. They have alnico magnets, sapphire bearings, and especially selected pivots to make possible the extremely sensitive 20 microampere movement.

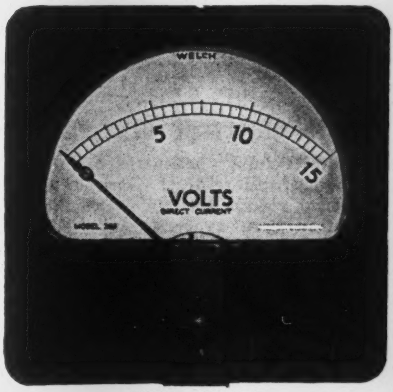
- **Accuracy 2% of full scale deflection**

These precision instruments are expertly designed, highly sensitive, sturdily built and adapted for work requiring the most rugged performance.

- Stable and Well-Damped
- Flush Mounting Bakelite Cases
- High Torque Ratio

MODELS

350—3½ inch round—2.4 inch scale
351—3 inch square—2.4 inch scale
451—4½ inch rectangular—3.5 inch scale



MODEL NO. 351

0
.2
.4
.6
.8
1.0
MILLIAMPERES
DIRECT CURRENT
MODEL 451
WELCH

MODEL NO. 451

TYPES

Microammeters 0-20 up to 0-500
Milliammeters 0-1 up to 0-500
Ammeters 0-1 up to 0-30
Voltmeters, various ranges, 100 to 50,000 ohms per volt
Zero Center Ammeters
DB Meters
Rectifier Instruments
Thermocouple Meters
Special Scaled Meters

A complete line of round, square, and rectangular meters is manufactured by Welch.

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Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **71** on inqiury card.

scale and pilot lights. External temperature setting knob is provided so that bolted cover does not have to be removed.—*West Instrument Corp., 4363 W. Montrose Ave., Chicago, Ill.*

For more information circle **307** on inquiry card.

BEARING OVERHEAT ALARM

New "Thermal Switch 3162" is a bearing overheat detector for airplanes, industrial machines, etc.; weighs one ounce; meets MIL-S-25345 and E-5272A. Its mercury contact thermostat will detect a bearing overheat temperature of 275°F and light a warning signal in cockpit in less than four seconds.—*Vapor Heating Corp., Dept. PR 56, 80 E. Jackson, Chicago 4, Ill.*

For more information circle **308** on inquiry card.

THERMOSCOPIC PELLETS

New "Tempil" pellet for 100°F is announced. Heretofore, lowest temperature rating for which "Tempil" products were available was 113°F because of problem of storing and shipping lower-temperature ratings in summer. Makers met demand for 100°F pellets for uses such as production-line work where 100°F was prescribed operating temperature. Shipment of new low-temperature pellets will be limited to off-summer months. If stored in hot weather, they will have to be kept under mild refrigeration.—*Tempil Corp., 132 W. 22d St., New York 11, N. Y.*

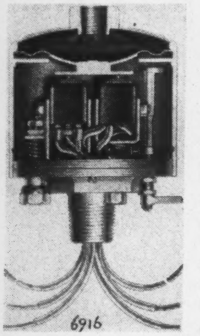
For more information circle **309** on inquiry card.

REVERSER FOR PLATING

New "Model GPR-18 Periodic Reverser," supplied in ratings from 50 amp to 3000 amp, assures better plating by preventing nodules around burrs, build-up around corners, thin deposits at center of work, etc. No irregular anode corrosion, nor passivity or blackening of copper anodes in cyanide plating. Synchronous motor timers assure stable time settings. All units unconditionally guaranteed for one year.—*Gates Electronic Co., 2090 Barnes Ave., New York 62, N.Y.*

For more information circle **310** on inquiry card.

DUAL PRESSURE SWITCH

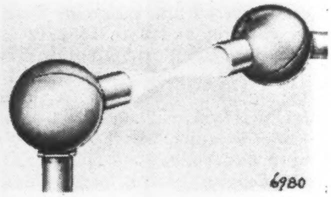


New "Meletron Model 432" is two pressure switches in one; can be used to signal when pressure rises (or falls) to danger zone and then to shut down system if pressure continues to rise (or fall) to a predetermined safety limit. System cannot be manually reactivated until pressure has been returned to a safe level. Switching elements can be electrically independent of each other, or two leads can control one circuit. Available in proof pressures of 6, 30 or 120 psi; with adjustable range from 0.05 to 100 psi.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*

For more information circle **311** on inquiry card.

PHOTOELECTRIC CONTROL

New "Standardized Electronic-Eye Systems" sense position, movement, texture, size, quantity, color, etc., without touch; can be quickly and easily installed; feature 5" spherical-shaped housings for relay and light source, each mounted directly on conduit which carries its leads. Sphere design permits easy swivelling in any direction. Sphere halves are interchangeable—with one spare half, system need never be out of service for repair.—*Hancock Industries, 6711 S. Sepulveda Blvd., Los Angeles 15, Calif.*

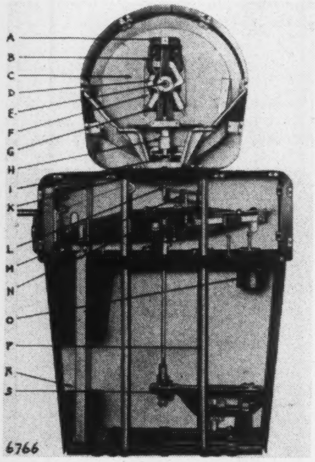


For more information circle **312** on inquiry card.

LOAD, FORCE, ACCELERATION

INDUSTRIAL SCALES

New "Floaxial" cabinet dial scales are said to eliminate possible human errors and insure "precision performance despite the most rugged operating conditions." Four new exclusive features: direct-reading dial, full swivel head, cage-type central column construction and controlled-speed dash-pot. Available in 36 models in capacities from 500 lb to 120,000 lb.—*Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.*

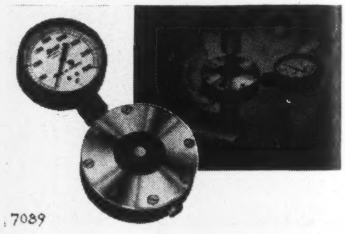


A. Mechanism frame; B. adjustable sector; C. direct-reading back chart; D. pendulum arm; E. indicator shaft; F. load tape; G. mechanism load yoke; H. oil seal; I. differential mechanism; K. Swivel base; L. load rod; M. auxiliary level; N. center-loading tare lever; O. controlled-speed dash-pot; P. cage-type column support; R. back balance; S. shelf lever.

For more information circle **313** on inquiry card.

FORCE GAGE

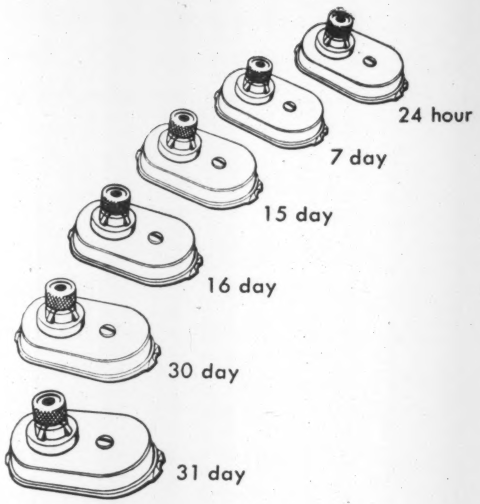
New hydraulic gage measures force between electrodes on spot welding machines, or between rolls on roll welders; also useful for weighing, compression tests, etc. Insulated contact surface prevents damage from accidental firing of welding equipment. Five capacities, from 1000 to 40,000 lbs; accuracy 1%.—*Webster Instrument, Inc., 11856 Mississippi Ave., Los Angeles 25, Calif.*



For more information circle **314** on inquiry card.

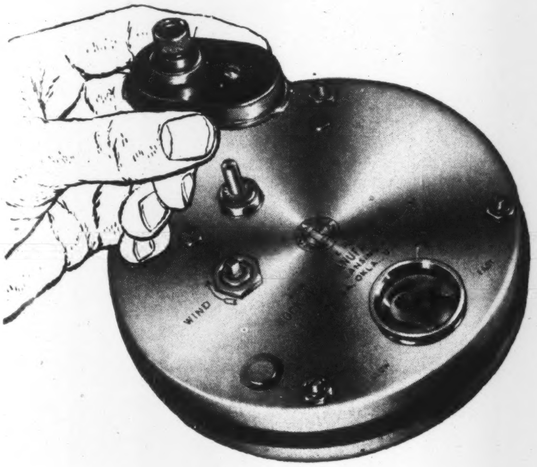
MINIATURE LOAD CELLS

New miniature "SR-4" load cells for electrical measurement of forces and weights up to 10,000 lb in com-


24 hour
7 day
15 day
16 day
30 day
31 day

New ROCKWELL
31 DAY CHART DRIVE

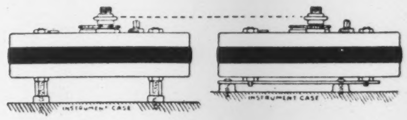
For Complete Records Around The Clock



The turret on top does the trick

Stops Estimating Even though your meter man forgets to wind it, this new Rockwell 31 day drive will still provide a complete rotation for the chart period.

Saves Money The six different rotation rates (as illustrated) assure complete flexibility in your measurement program. You'll save through making less trips to the meter; having fewer charts to read.

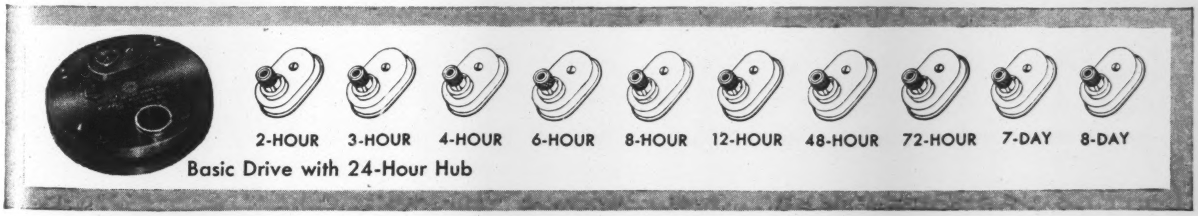

INSTRUMENT CASE
INSTRUMENT CASE

Fits Practically All Instruments The case dimensions are the same as the Rockwell Standard Chart Drive. Simple adaptors, as shown above, permit correctly locating it both as to position and height in practically any instrument.

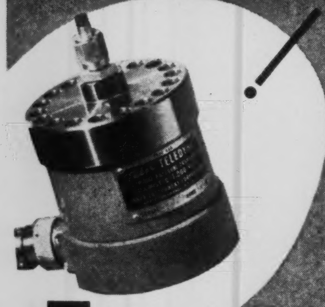
ROCKWELL MANUFACTURING COMPANY
Instrument Division • Box 2396, Tulsa, Okla.

Atlanta Boston Charlotte Chicago Dallas Denver Houston Los Angeles
Midland, Tex. New Orleans New York N. Kansas City Philadelphia Pittsburgh
San Francisco Seattle Shreveport Tulsa

ALSO STANDARD ROCKWELL CHART DRIVES, 24 Hour Hub, 11 Rotations


2-HOUR
3-HOUR
4-HOUR
6-HOUR
8-HOUR
12-HOUR
48-HOUR
72-HOUR
7-DAY
8-DAY
Basic Drive with 24-Hour Hub

For more information circle **72** on inquiry card.



Newest friend

. . . to the AUTOMATIC PROCESS

Teledyne

BONDED STRAIN GAGE

ELECTRICAL PRESSURE TRANSMITTER

● Today's automatic process can involve extremely high pressures, with the often present danger of explosion. The new Taber Teledyne is designed and constructed to function with a stability of calibration and high resolution under the most extreme operating conditions. This instrument is ruggedly durable to withstand heat, shock and vibration. The Teledyne, therefore, is an important component in the electrical pressure telemetering process.

EASILY DISASSEMBLED FOR CLEAN-OUT AND REPAIRS

● ● The new Taber Teledyne is the answer to stringent requirements. Its rugged construction with bonded strain gage will withstand shock and vibration under extreme operating conditions. High frequency response and linear output over full pressure range. High overload can be provided in all ranges. Stainless steel pressure chamber for strength and corrosive protection. Temperature compensation for zero shift and sensitivity change.

Write for illustrated literature.

TABER INSTRUMENT CORPORATION
SECTION 75
111 Goundry St., N. Tonawanda, N.Y.

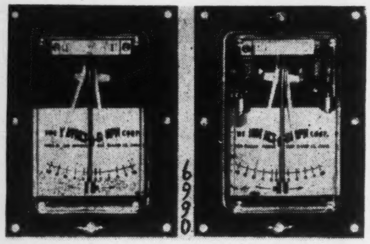
For more information circle **73** on inquiry card.

pression, accurate to 0.25% of full range, are less than 2" diam and 2¾" high over-all; are not intended to replace larger cells of same capacities and accuracy: small size achieved at a sacrifice in side load sensitivity.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **315** on inquiry card.

IMPACT REGISTER

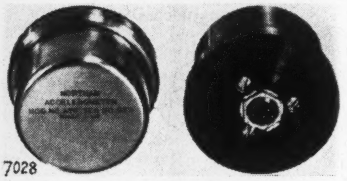
New impact register, introduced with help and suggestions of New York Central, should interest shippers as well as carriers. It is maker's low-priced "Yard Recorder," originally made for PRR, with addition of specially-calibrated counters whose purpose is to record (in addition to maximum shock the freight car receives) the actual number of over-speed impacts from either direction. New recorder is an educational tool for those who handle freight cars; can be utilized to study and to evaluate blocking and bracing methods.—*Impact-O-Graph Corp., 1900 Euclid Ave., Cleveland 15, Ohio.*


6990

For more information circle **316** on inquiry card.

ACCELERATION PICKUP

New "Model A-7T" variable-inductance pickup, for use in FM-FM telemetering systems, is intended for static and dynamic measurement of linear acceleration and is available in ranges from ±1G to ±100G. Overloads of 4 times rated range or of 60G, whichever is greater, will not damage unit. Internal temperature of 160°F is thermostatically maintained to provide good stability and constant damping (0.7 critical is standard).—*North American Instruments, Inc., 2420 N. Lake St., Altadena, Calif.*

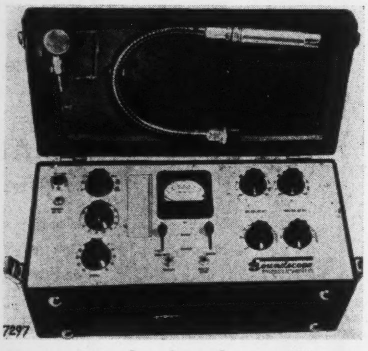

7028

For more information circle **317** on inquiry card.

VIBRATION, SOUND

SOUND LEVEL METER AND ANALYZER

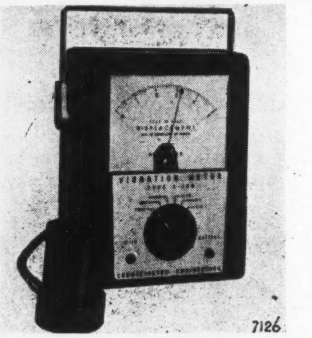
New "Soundscope" replaces four instruments: It can be used (1) to measure over-all noise as a sound level meter; (2) to analyze this sound as an octave band analyzer; (3) as a narrow-band analyzer; (4) its built-in oscillator serves for electrical and acoustical calibrations. Weight (about 20 lb) is said to be less than ⅓ that of older instruments. Design feature is minimization of erroneous readings caused by external mechanical or electrical vibrations: it far exceeds ASA specs on mechanical and electrical shielding. Analyzer input jack permits analyzer section to be used by itself: for example, a tape recording can be analyzed. Output jack permits monitoring signal by an oscilloscope, by earphones, by a recorder, etc.—*Mine Safety Appliances Co., Pittsburgh 8, Penna.*


7297

For more information circle **318** on inquiry card.

VIBRATION METER

New "Type 1-128" battery-operated all-transistor vibration meter for 10- to 1000-cps frequency range will find uses in making flightline vibration checks, troubleshooting machine tools, and performing other tests away from a-c lines. In addition to greatly reducing battery drain, all-transistor design minimizes microphonics and



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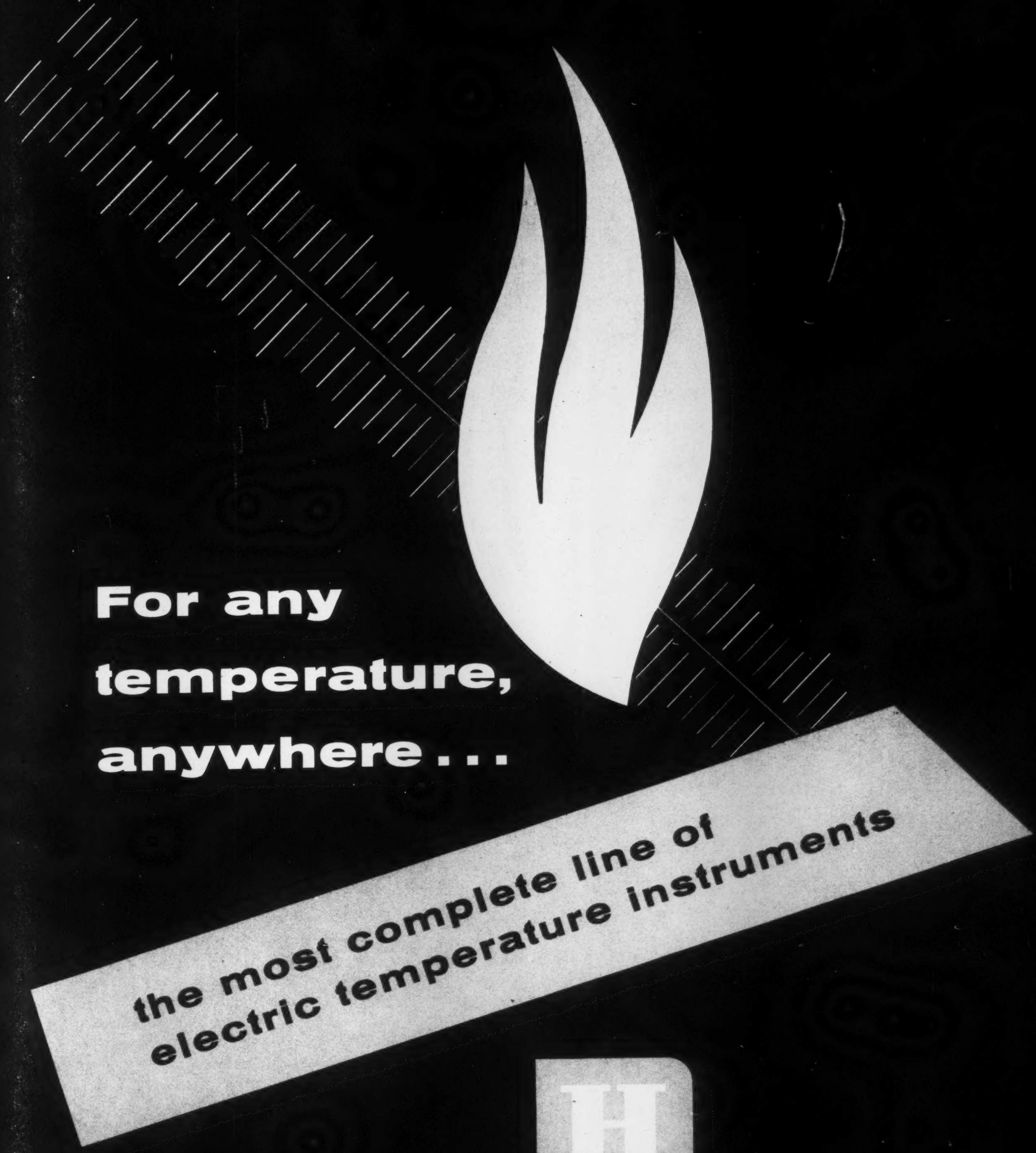
Circle **74** on inquiry card.→


For any temperature, anywhere . . .
the most complete line of electric temperature instruments
H
HONEYWELL

for accuracy, versatility, price

...Let your application decide which Honeywell instrument

fits your needs

GOT a temperature measurement or control job to handle? There's no need to "shop around." For from *one* source—Honeywell—you can be sure of getting exactly the right instrument to fit your needs.

This is the time-saving—and money-saving—way to choose instruments. You can choose from the most complete, most diversified line of pyrometric instruments on the market. Your selection can hit the application right on the button—giving you the performance you need at the price that fits your budget.

For simplified indicating control, Honeywell offers a line of economical millivoltmeter instruments . . . *Pyr-O-Vane* controllers, with a variety of electric control forms . . . and *Protect-O-Vane* controllers for excess temperature safety cut-off.

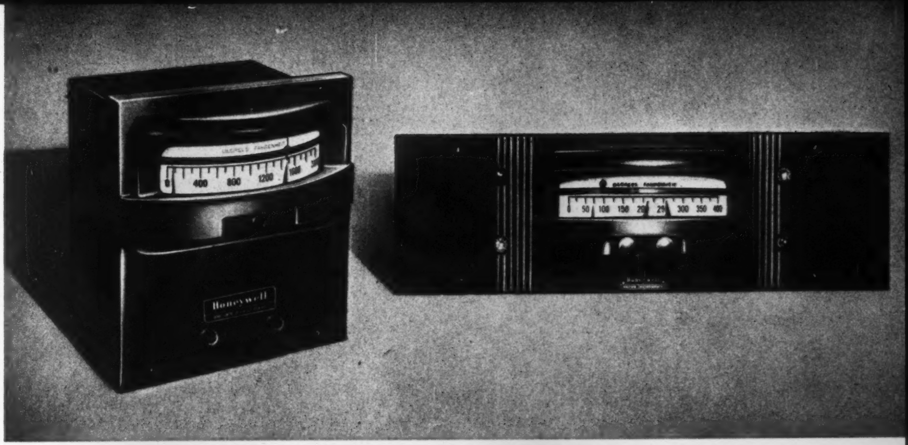
For more exacting applications, a new series of instruments—the "Special" *ElectroniK* line—is now available. They provide many of the forms of automatic control you can get with the "Precision" line. And they cost less . . . bringing *ElectroniK* performance within the reach of even wider areas of application.

For the peak in precision and versatility, there's the "Precision" *ElectroniK* line. This is the pioneer "continuous balance" electronic instrument that thousands of plants and laboratories have used for many years. It's available in eleven basic models, and can provide automatic control action from the simplest to the most advanced types.

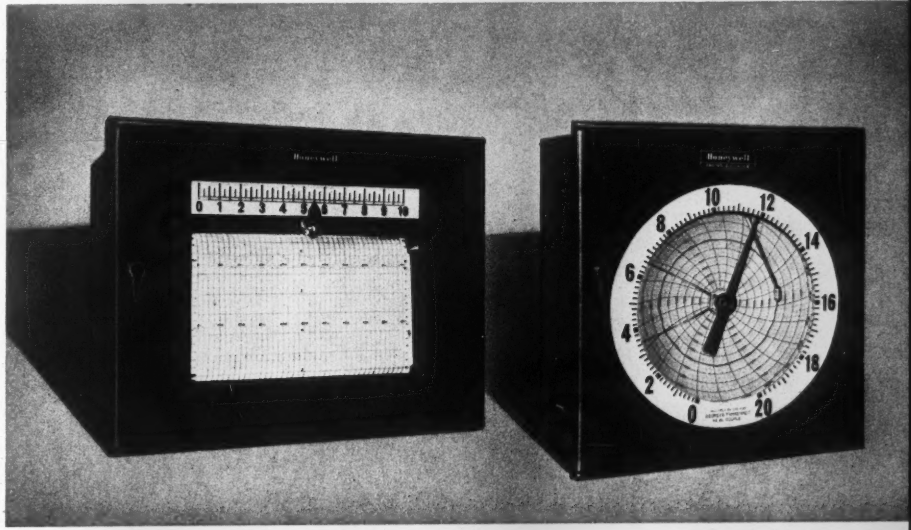
Your local Honeywell engineer will be glad to help you determine which type of instrument best fits the needs of your own application.

Call him today . . . he's as near as your phone.

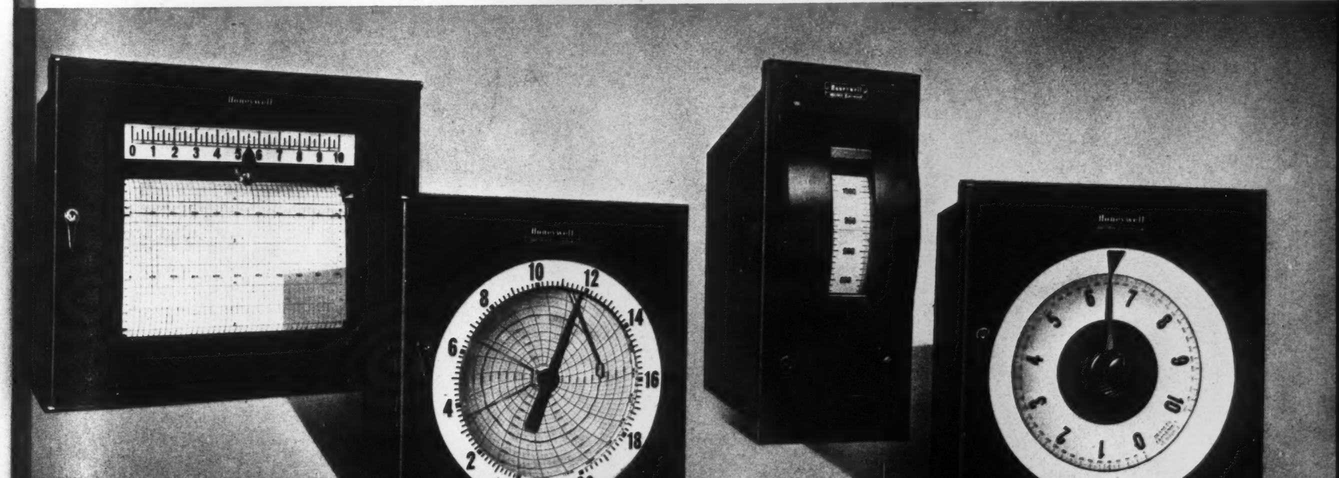
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.



Millivoltmeter Instruments give dependable and accurate service, at low cost. High-resistance galvanometer circuit minimizes effects of varying length of extension wires. Plug-in unit design speeds servicing. *Pyr-O-Vane* controllers, in either horizontal or vertical case, give snap-action electronic vane control or pulse-type time-proportioning control.

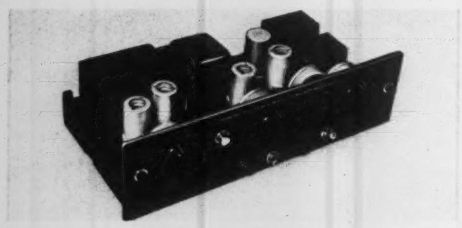


Special Class 14 *ElectroniK* instruments are calibrated to an accuracy of ± .5% of scale span . . . priced lower than the Precision line. Includes strip chart and circular chart recorders and recording controllers, also circular scale indicating controllers. Electric control of the contact, time-proportioning or position-proportioning type is available.

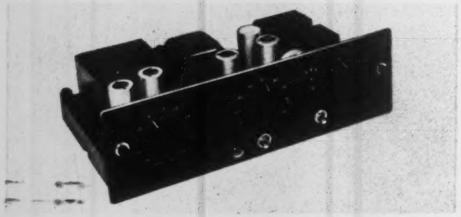


Precision Class 15 *ElectroniK* instruments have calibrated accuracy within ± .25% of scale span. Models include strip and circular chart recorders, Precision Indicators, circular scale indicating controllers, Vertical Scale Precision Indicator. Electric and pneumatic control from simplest to most complex types. Multi-point monitoring or recording of 2 to 400 separate inputs.

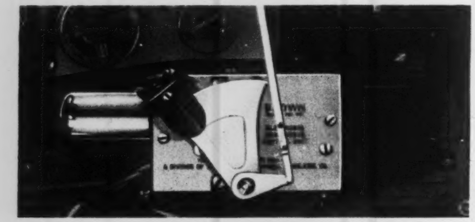
Honeywell electric control units provide control action to fit your process



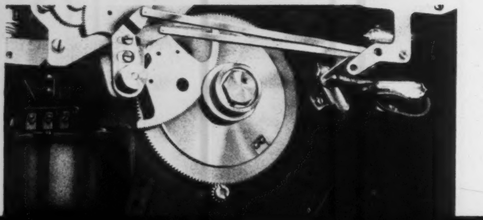
Electr-O-Line Control Unit, used with *ElectroniK* instruments, gives position-proportioning control of an electric motorized valve. Proportional band and reset rate are both adjustable over wide ranges. Primarily used with fuel-fired furnaces.



Electr-O-Pulse Control Unit, also used with *ElectroniK* models, gives time-proportioning action . . . turns input alternately on and off in pulses of variable length. Regulates a contactor or solenoid valve. Proportional band, reset rate and cycle time are adjustable over wide ranges.



Electr-O-Vane Control Unit, shown here mounted inside an *ElectroniK* instrument, gives extremely sensitive snap acting electronic control. Switching action, initiated by motion of a lightweight vane between oscillator coils, occurs when pen movement is only a few thousandths of an inch. No mechanical load on the recording pen.



Mercury Switch Control Unit uses completely enclosed construction that eliminates dirt, dust and corrosion problems. Up to four units can be combined in a single instrument to give multi-zone control.

The HSM Plan

HONEYWELL SUPPLIES MAN

saves time and money on your pyrometer supplies purchases

You can purchase expendable supplies for your temperature instruments . . . thermocouples, wires, wells, recorder charts, ink . . . at maximum convenience and economy through the HSM (Honeywell Supplies Man) Plan.

For a discussion of how this plan can work for you, call your local HSM, at your nearby Honeywell office . . . as near as your phone.

● REFERENCE DATA: Write for Pyrometer Supplies Buyers' Guide No. 100-6 . . . and for the booklet, "The HSM Plan."

HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

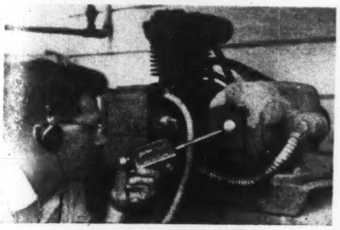
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

eliminates warm-up time. When used with maker's self-generating pickups, vibrometer indicates directly and unambiguously in mils peak-to-peak displacement.—*Consolidated Electrodynamics Corp., Pasadena, Calif.*

For more information circle **319** on inquiry card.

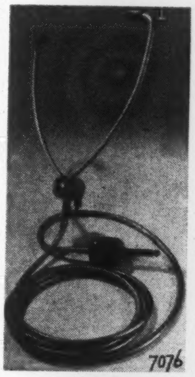
INDUSTRIAL "STETHOSCOPE"

New "Audio-Scope" pocket-size transistorized audio-amplifier detects and amplifies (gain up to 85 db) sounds made by termites, leaks in buried pipelines, defective bearings, etc; uses three miniature hermetically-sealed low-noise transistors. Dry-cell battery is good for about 100 hours of normal use. Comes with leather carrying case.—*Fisher Research Laboratory, Inc., Palo Alto, California.*



For more information circle **320** on inquiry card.

"LIVE-EFFECT" HEADSET



New "Duodyne" represents a new concept in headset design resulting in better perception of oral sound; was developed from data supplied by a U.S. Army research project at U. of Cincinnati, which revealed that a few milliseconds' time delay in reception in one ear contributed to better understanding of speech. New headset creates audio effect of actual "presence at the source of the sound" by inducing a 5-millisecond time delay in transmitting sound to one earpiece. One dynamic driver is located in a Tenite housing with PL-55 plug and is separated from second driver in tone-arm junction by 5 ft of plastic tubing. Each driver feeds a separate ear; one driver emphasizes highs, the other, lows. Headset frequency response 100 to 8,000 cps. Plastic ear plugs are removable for easy cleaning.—*Telex Inc., Telex Park, St. Paul 1, Minn.*

For more information circle **321** on inquiry card.

TIME, SPEED, COUNT

THERMAL TIME DELAY RELAY

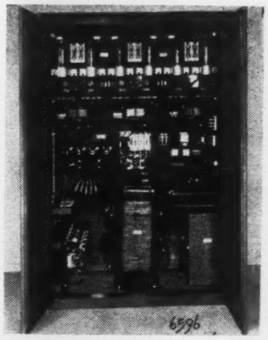
Actual size
Belltron
THERMAL TIME DELAY
6726

New "Micro-Mite," said to be the smallest thermal time delay relay available, features positive adjustment, ambient compensation from −85°F to 194°F, maximal vibration resistance, quick delivery from basic stock units. Factory delay settings can be shifted later without interfering with hermetic seal. Available in five overlapping timing ranges from 5 to 99 seconds.—*Belltron Mfg. Co., 204 Second St., Elizabeth, N. J.*

For more information circle **322** on inquiry card.

MOTOR SPEED CONTROL

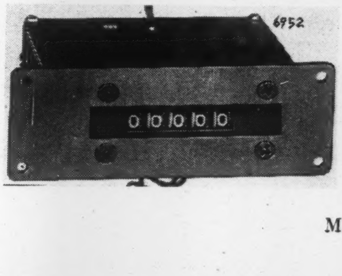
New "Theratrol" thryratron speed control allows constant full-load torque on d-c motors from 10 to 50 hp, 10 to 1 ratio. It comprises a dc motor with an electronic rectifier power supply. Maximum armature current is limited by a control circuit which can be adjusted from 100 to 200% of full load and current cannot exceed this preset value even though motor is stalled with speed control in maximum speed position.—*Dep't IUP, Ther Electric Works, Dept. 870, 17 S. Jefferson St., Chicago 6, Ill.*



For more information circle **323** on inquiry card.

TWO-WAY COUNTER

New "Model 5-Y-8602-MF Add and Subtract Productimeter" comes with



Endurance Rated
ELECTRIC COUNTERS and ACTUATORS
to Fit every need

200,000,000 COUNT LIFE

PIC SUPER-WIZARD

1000 CPM.
5 watts input.
Balanced Armatures.
4 and 6-digit models in basemount, panelmount and dustproof enclosed types for 60, 40-50, 25 cycles and DC; all voltages to 230.
Purchase cost only 18c per million counts.

50,000,000 COUNT LIFE

PIC 600

1000 counts per minute
7 watts power consumption
Balanced armature
Quiet operation. No AC hum.
Tamper proof housing.
Lubrication not required.
Available in basemount and panelmount models—also to count dozens, for 60, 40-50, 25 cycles and DC; all voltages to 150.

6,000,000 COUNT LIFE

PIC MERCURY
4-digit Reset
600 Counts per minute.
3 watts power input.
4-digit Basemount and Panelmount models also to count dozens — all voltages to 115, AC or DC.

3,000,000 COUNT LIFE

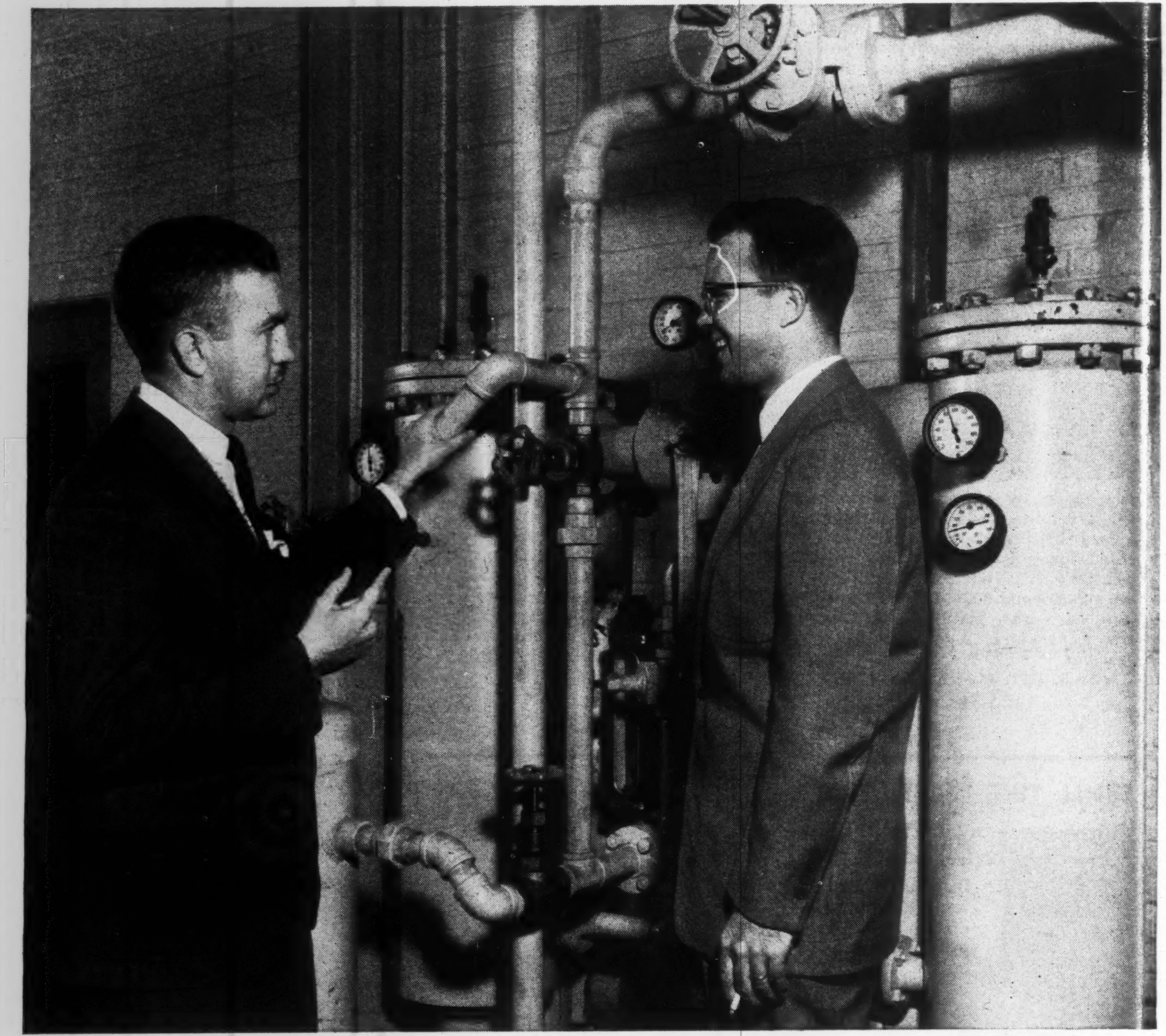
PIC MERCURY
5-digit non-reset
600 Counts per minute.
3 watts power input.
Tamper proof construction.

See your PIC Representative or write

PIC
PRODUCTION INSTRUMENT CO
702 W. Jackson Chicago 6, Illinois

For more information circle **75** on inquiry card.

←Circle **74** on inquiry card.



"Is this that Pritchard Hydryer you've been raving about, Ben?"

"Yes, and isn't it a honey?"

"You're pretty happy about it aren't you?"

"You bet I am. Remember those few months before we got our Hydryer? Those nights and weekends we had to work trying to keep all those precision instruments operating. If it wasn't moisture that was fouling things up, it was corrosion."

"I remember only too well. Say, Ben, how did you get a line on that Pritchard Hydryer in the first place?"

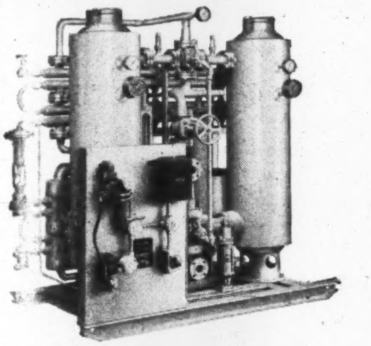
"I sent for a copy of their bulletin on the Hydryer. After I read it I talked it over with the chief and we ordered ours. You know this unit does everything their literature said it would. Right now we're pulling 63 pounds of water from our instrument air every day. It dries 100 SCFM at 100-psig., and 90°F."

"All I know is that things are a lot different around here since we put that Hydryer in. C'mon, let's go home. That air is in good hands."

J. F. PRITCHARD & CO. OF CALIFORNIA
4625 Roanoke Parkway, Kansas City 12, Mo.

For more information circle **76** on inquiry card.

"Is this that Pritchard Hydryer you've been raving about, Ben?"



PRECISION INSTRUMENTS DEMAND DRY AIR
The PRITCHARD HYDRYER* DELIVERS IT!

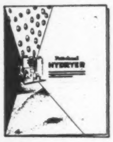
The Pritchard HYDRYER is a low-cost, packaged dehydration unit. It is ideally suited for use with precision instruments. The HYDRYER effectively removes moisture from air, carbon dioxide, synthesis gas and many other gases.

These exclusive design features make the HYDRYER superior to any other such unit on the market today:

- 100% of all air or gas entering is dried without loss.
- Full line pressure reactivation.
- Purging eliminated; HYDRYER uses inlet main air stream for reactivation.
- Longer adsorbent life; no movement due to pressure changes, high velocity.
- No moving parts . . . simplified design . . . . . plus many, many more!

*Registered Trade Name

GET THE ENTIRE HYDRYER* STORY!



Get all the facts. Send for Pritchard HYDRYER Bulletin No. 16.0.081 on your company letterhead. No charge or obligation.

INDUSTRY'S PARTNER FOR PROGRESS

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A DIVISION OF J. F. PRITCHARD & CO.
Dept. 536, 4625 Roanoke Parkway
Kansas City 12, Missouri
COOLING TOWERS • GAS & AIR TREATING EQUIPMENT
REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

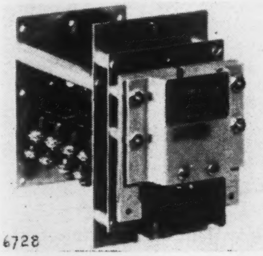
For more information circle 76 on inquiry card.

mounting plate. Entire assembly can be placed into a panel from front and securely fastened from front. For inventory control, etc., it adds one on impulse from one contact switch, and subtracts one on impulse from a second switch. Up to 500 counts per minute.—*Durant Mfg. Co.*, 1914 *Buffum St., Milwaukee* 1, *Wis.*

For more information circle **324** on inquiry card.

REPEAT-CYCLE TIMER

New "Model AGS-4," developed primarily for balloon instrumentation is believed to be "the smallest, lightest and to operate on less power than any previously available." Weight 6 oz; four sp-dt switching circuits. Operating power: 8 ma at 6 vdc. New brush assembly gives better than 3000 hours continuous operation.—*Brailsford & Co., Inc., Milton Point, Rye, N. Y.*



For more information circle **325** on inquiry card.

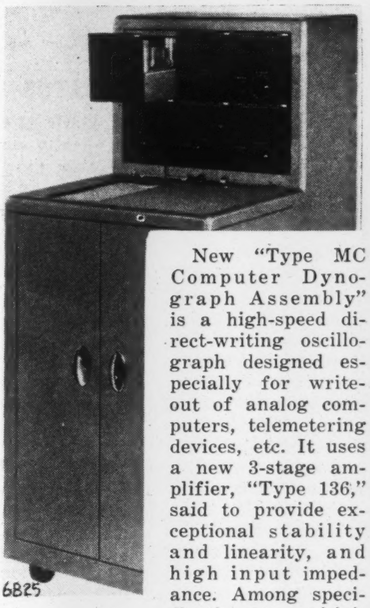
SPEED INDICATOR

New portable industrial "Model PSI" is a dual purpose device: measures shaft speed in rpm, or velocity of belts, etc., in fpm; weighs 1 lb; incorporates basic electric circuit used in maker's tachometers. Choice of ranges and of adaptor sizes and shapes.—*Sun Electric Corp., Harlem & Avondale, Chicago* 31, *Ill.*

For more information circle **326** on inquiry card.

COMPUTING and DATA PROCESSING

COMPUTER OSCILLOGRAPH

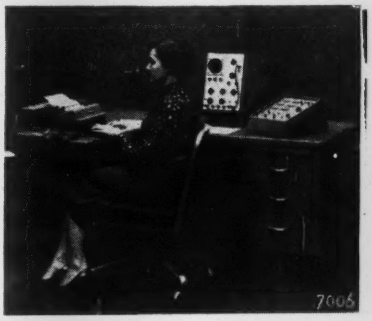


New "Type MC Computer Dynograph Assembly" is a high-speed direct-writing oscillograph designed especially for write-out of analog computers, telemetering devices, etc. It uses a new 3-stage amplifier, "Type 136," said to provide exceptional stability and linearity, and high input impedance. Among specifications: sensitivity adjustable over a range of about 0.1 to 0.3 v/cm; linearity of amplifier within 0.1% up to 5v output; pen deflection linear within 1% through 4 cm deflection; maximum available deflection about 10 cm; absolute stability with no drift of pen zero position. —*Offner Electronics Inc.*, 5320 *N. Kedzie Ave., Chicago* 25, *Ill.*

For more information circle **327** on inquiry card.

DIGITAL COMPUTER

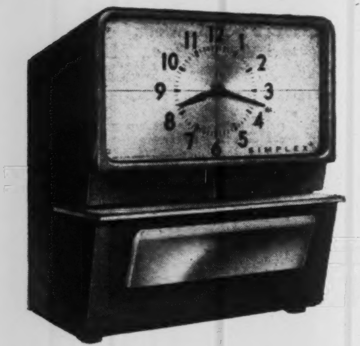
New "ALWAC III-E" low-cost medium-speed high-capacity electronic digital computer features "greatest flexibility including ease of programming of any machine in its price class," is designed to pick up two instructions simultaneously; has been improved to allow automatic modification of address of number to be operated on by an instruction.—*Logistics Research Co.*, 141 *S. Pacific Ave., Redondo Beach, Calif.*



For more information circle **328** on inquiry card.

AUTOMATIC COST AND PAYROLL RECORDER

New "Model KCF," arranged for either trigger trip or touch plate registration, furnishes indisputable payroll and cost records of each employee's time. Program attachment can be installed to handle signal systems throughout the plant. Printed

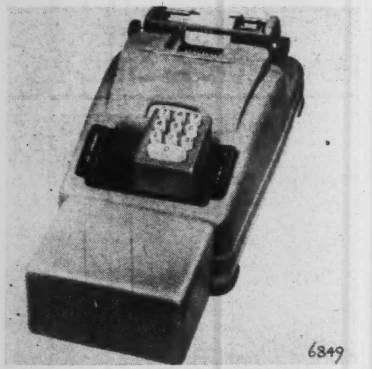


cards or paper of any size can be used. Wage-hour certified records are computed and each machine has exclusive two-color registrations for easier computation.—*Simplex Time Recorder Co., Gardner, Mass.*

For more information circle **329** on inquiry card.

REMOTE TOTALIZER

New "ERA 503" remote electric totalizer for use with computers, digital converters, etc., adds, subtracts,

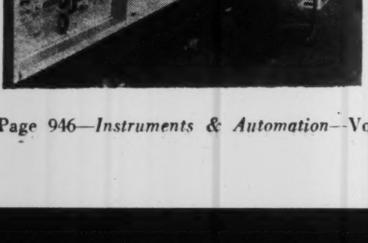


totalizes and prints both entries and totals, and transmits digital values and control functions to other data handling equipment.—*Remington Rand Univac,* 1902 *West Minnehaha Ave., St. Paul W4, Minn.*

For more information circle **330** on inquiry card.

ELECTRONIC COMPUTER

New "Datamatic 1000" coordinated data-processing system employs high-speed computer principles to speed all phases of clerical operations, from accounting and billing to sales analysis, inventory and production control; also provides management with continuous compiling and processing of reports. System can handle addition of 4,000 sets of 11-digit numbers in one second, or compare 5,000 or multiply 1,000 per second.—*Datamatic Corp., Newton Highlands, Mass.*

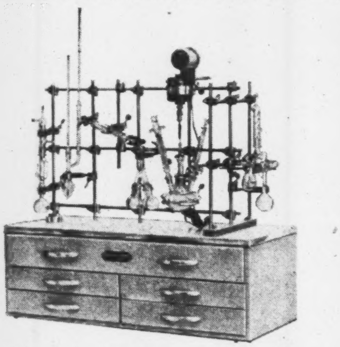


For more information circle **331** on inquiry card.

LABORATORY EQUIPMENT

SMALL ORGANIC CHEM LAB

New "Bantam-ware," a complete small organic chemistry laboratory, has ample basic components to enable fractionation, steam, atmospheric and vacuum distillation, chromatographic analysis, extraction, filtration, reflux and separation. It includes accessories for supporting, clamping, heating, agitating and storing. Cabinet provides convenient parts storage.—*Kontes Glass Co., Vineland, N. J.*



For more information circle **332** on inquiry card.

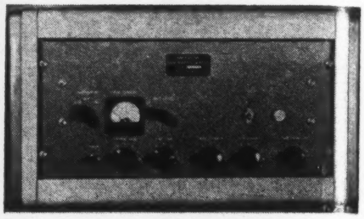
DISTILLATION APPARATUS

Newly redesigned "Automatic Distillation Apparatus," specifically designed for distilling petroleum products according to ASTM D 86, it also distills many other products. Accuracy is even closer than tolerances allowed by ASTM.—*Precision Scientific Co.* 3737 *W. Cortland St., Chicago* 47, *Ill.*

For more information circle **333** on inquiry card.

AMPLIFIER AND PHASE-SENSITIVE DETECTOR

New "Model HC" is especially designed for use in measurement of radiation in UV and IR as well as visible, Input level of 8-stage amplifier is engineered for low-noise characteristics. Full-scale sensitivity 5 uv; output sufficient to drive a strip-chart recorder. Use of feedback aids in maintaining linearity better than 1% and zero drift under 1%. Selenium bridge type phase-sensitive detector provides stable performance.—*Baird Associates, Inc.,* 33 *University Rd., Cambridge* 38, *Mass.*



For more information circle **334** on inquiry card.

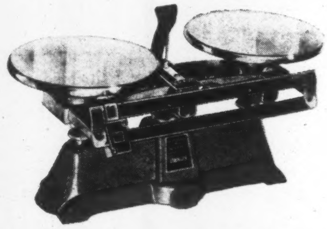
TANK THERMOMETER

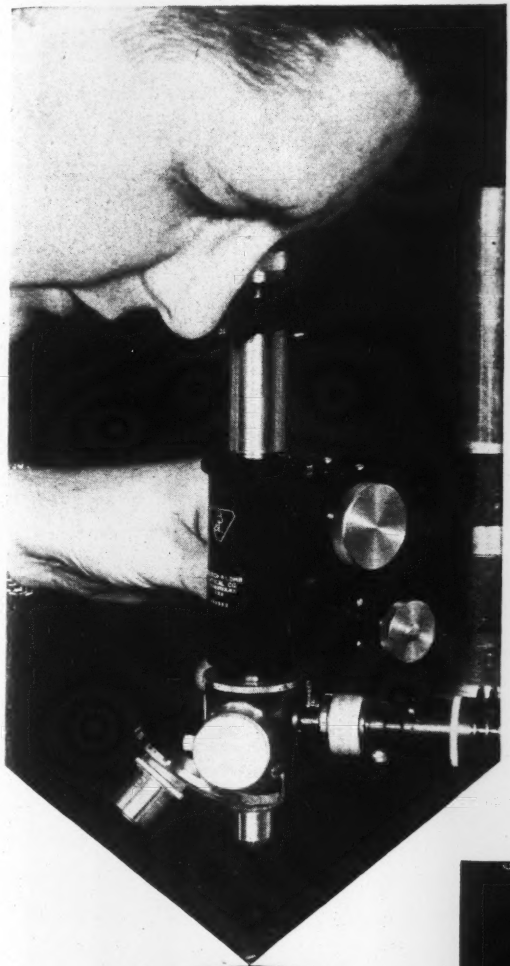
New "Scoopmaster" tank thermometer is especially designed for applications where chemical action of such compounds as aromatic hydrocarbons or petroleum products is critical. Cup case (120-ml capacity) is molded of smooth heat-resistant nonsparking low-thermal conductivity plastic for maintenance of sample temperatures. Various ranges from −30°F to 500°F; graduations permanently engraved on the 14" red-reading wide-bore tube.—*Weksler Thermometer Corp.,* 195 *E. Merrick Rd., Freeport, L. I., N. Y.*

For more information circle **335** on inquiry card.

LABORATORY BALANCE

New "Model 1550-S Harvard Trip Balance" embodies many new features, among them: (1) box-end beam construction, (2) recessed balance adjustment units, (3) angle-view dial with pointer shield, (4) self-aligning agate bearings, (5) sliding type poise with center pointed indicating panel, (6) angle view relief etched





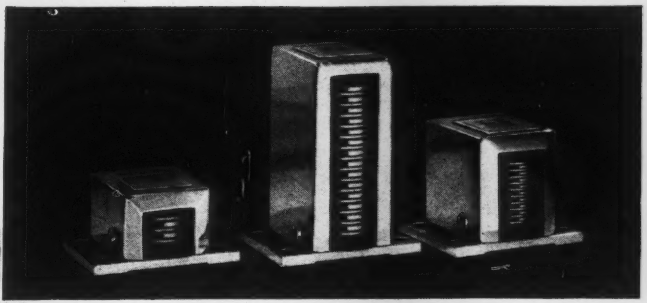
BRUSH *announces...*

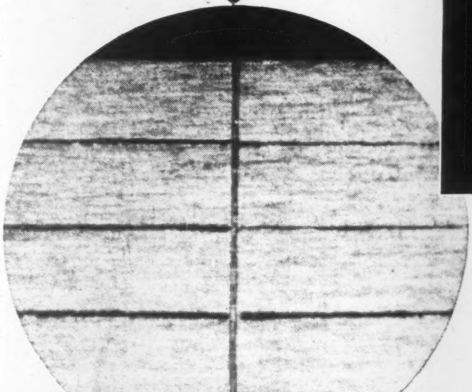
NEW PRECISION MAGNETIC HEADS FOR CRITICAL RECORDING APPLICATIONS

Brush now offers a new design concept in multichannel magnetic heads which provides extremely close tolerances to assure accuracy in recording and reproduction. These heads have already been proven in exacting airborne and missile applications.

ADVANTAGES

- **Uniform output assured by close mechanical tolerances on track width and channel spacing ... ± .002 in. maximum.**
- **Channel-to-channel timing accuracy provided by precise gap alignment... ± .0001 in. maximum.**
- **Crosstalk minimized by full shielding.**
- **Sustained accuracy under severe operating conditions assured by our new construction techniques.**





400X enlargement shows high precision gap and track construction.

AVAILABILITY

Brush offers these heads in three designs: providing 7, 8, or 13 tracks per inch. Heads may be interlaced to provide up to 25 tracks per inch. Modifications or new designs using this construction technique may be made to your requirements. Consult Brush on your magnetic head needs—write Brush Electronics Company, Department A-50, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio
BRUSH ELECTRONICS
DIVISION OF
CLEVITE
CORPORATION

For more information circle **79** on inquiry card.

Analog Computing for One and All

with GAP/R modular components

The Model K2-X Operational Amplifier is an octal-based plug-in unit which nobly serves as nucleus for accurate feed-back computing. With an output of ±100V the K2-X is priced at $24. The K2-W at $20. puts out an ample ±50V with less power needed.

Model K2-P is a Stabilizing Amplifier used in tandem with the K2-W or K2-X. It provides long term DC Stability measured in microvolts. All plug directly into the HK (shown below) or other environments. The K2-P having inherent stability below 0.1 MV is priced at $55.

The Model HK Operational Amplifier in the standard version offers 10 K2-W Amplifiers for analog calculations of infinite variety. A stabilized HK using K2-X and K2-P *"paired"* plug-ins provides greater output plus stability. The *standard* HK with 10 K2-Ws is $360. The *stabilized* HK with 5 of above "pairs" is $555.

Supplied also in a self-powered version as the compact Model HKR Operational Tenfold, all manifolds can be purchased in either *standard* or *stabilized* forms or in other combinations.

For rapid utilization of the HK or HKR, Model K- Modular Assembly units are offered either in kit form or assembled as Adder, Coefficient, Differentiator, Integrator or Unit-lag Passive Operational Plug-ins. Prices furnished on request.

One of the many "power packages" from GAP/R is the Model R-100 Regulated Power Supply, conservatively rated at 100 ma, ±300VDC, and modestly priced at $130.

Indicated below are two possible arrangements whereby your laboratory or engineering office can obtain a basic computing facility at minimum cost.

20 OPERATIONAL AMPLIFIERS Plus Regulated Power		10 STABILIZED AMPLIFIERS Plus Regulated Power	
2 HKs (with 20 K2-Ws)	$720.	2 HKs (10X's + 10 P's)	$1110.
1 R-100 Power Supply	130.	2 R-100 Power Supplies	260.
	$850.		$1370.

For more details and other information please write to:

George A. Philbrick Researches, Inc.
230 Congress Street, Boston 10, Massachusetts

GAP/R

For more information circle **80** on inquiry card.

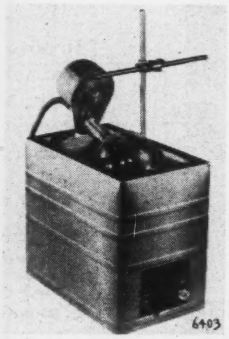
NEW INSTRUMENTS

beams, (7) undivided tare beam and poise. Earlier models' exclusive features are retained. Available in various Metric and English graduations and capacities.—*Ohaus Scale Corp., Union, N. J.*

For more information circle **336** on inquiry card.

EVAPORATOR

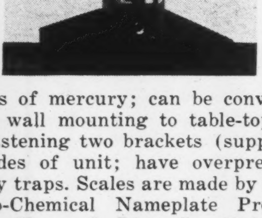
New "Flash-Vac" rotary film evaporator incorporating many new features is for use with flasks of 100 c.c. and larger; is suitable for separating heat- and air-sensitive solutions; separating concentrated solutions of high-boiling-point solvents such as water and butanol.—*Labline, Inc., 3070-82 W. Grand Ave., Chicago 22, Ill.*



For more information circle **337** on inquiry card.

WELL TYPE MANOMETERS

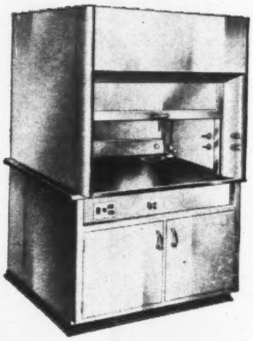
New "Cat. 105" manometers measure pressure, vacuum, and differential pressure either in inches of water or inches of mercury; can be converted from wall mounting to table-top use by fastening two brackets (supplied) to sides of unit; have overpressure safety traps. Scales are made by Dietz Photo-Chemical Nameplate Process. —*The Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.*



For more information circle **338** on inquiry card.

FUME HOODS

New "Standard designed Fume Hoods" are available with constant air-flow, permitting hoods in a lab to function as parts of air-conditioning system.—*Duralab Equipment Corp., 980 Linwood St., Brooklyn 8, N.Y.*



For more information circle **339** on inquiry card.

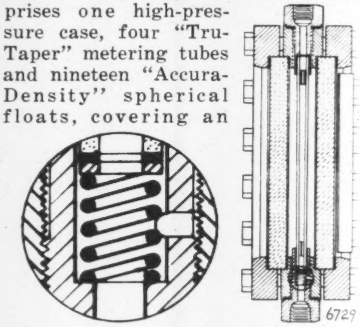
MONOCHROMATOR ACCESSORY

New monochromator condenser provides more efficient illumination for ultraviolet microscopy and photomicrography than do previous models; permits uv light source to be moved as far back as 10¼" from photomicrographic equipment; illuminates complete field of view of microscope image.—*Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.*

For more information circle **340** on inquiry card.

ROTAMETER KIT

New "Hi-Pressure" Lab Kit," for service to 3000 psi at 200°F, comprises one high-pressure case, four "Tru-Taper" metering tubes and nineteen "Accura-Density" spherical floats, covering an enormous range of flow-rates. Unique feature: equalizing vent preventing rupture of glass metering tubes at high pressures.—*Brooks Rotameter Co., Lansdale, Penna.*



For more information circle **341** on inquiry card.

LAB GLASSWARE ITEMS

Several new products help make laboratory work easier and more efficient. Among them: (1) Pyrex brand conical centrifuge tube with screw cap, for use when separating material with a volatile constituent lighter than conventional stoppered tubes; available in plain or graduated types for regular or heavy duty. (2) New tubular fritted filters include a new porosity (Very Fine) pore diameter half-way between standard Fine and Ultra-Fine, for use in general bacteria filtrations es-

WHAT'S NEWS AT BRISTOL . . .

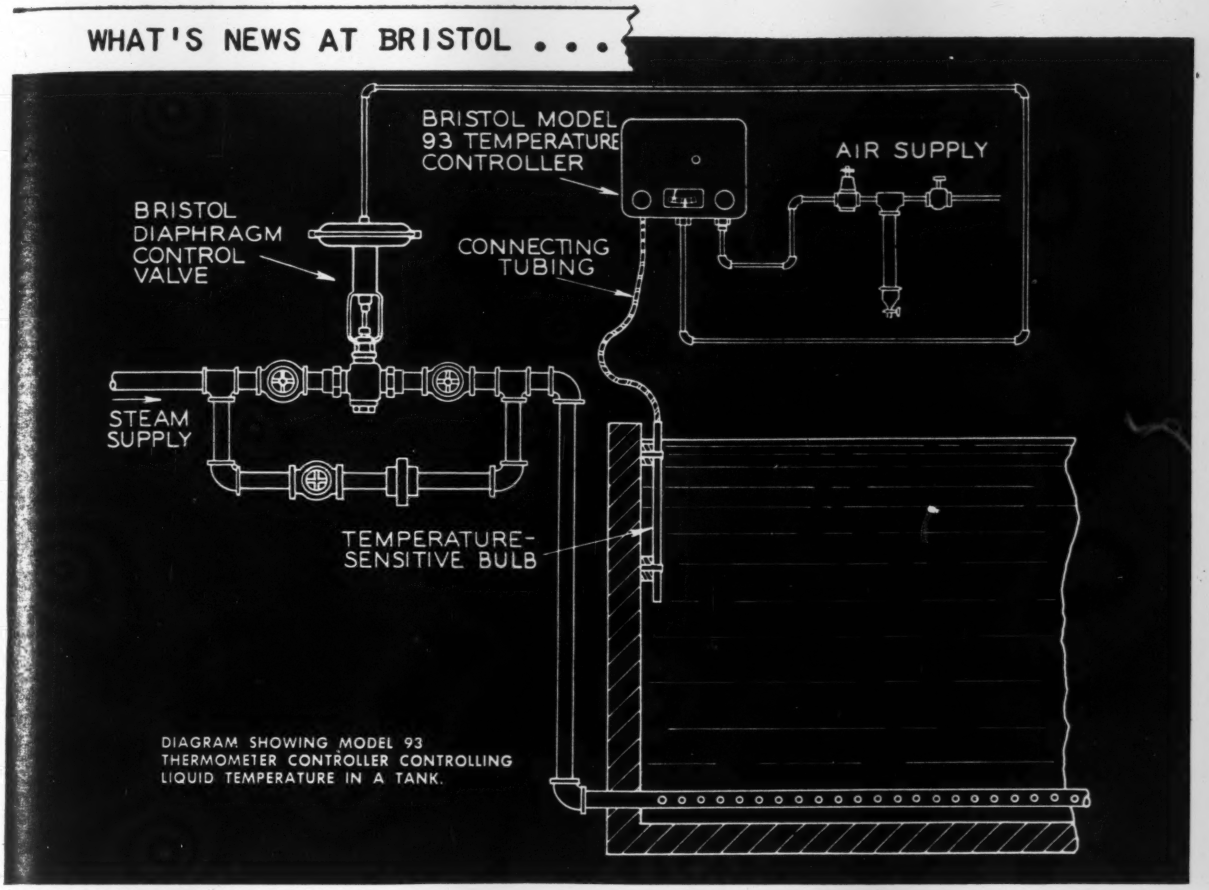
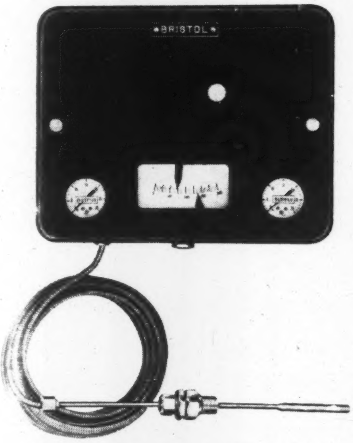

BRISTOL MODEL 93 TEMPERATURE CONTROLLER
AIR SUPPLY
BRISTOL DIAPHRAGM CONTROL VALVE
CONNECTING TUBING
STEAM SUPPLY
TEMPERATURE-SENSITIVE BULB

DIAGRAM SHOWING MODEL 93 THERMOMETER CONTROLLER CONTROLLING LIQUID TEMPERATURE IN A TANK.

Where variables must be controlled but not necessarily recorded



MODEL 93 Thermometer Controller. Temperature Controllers are available in a variety of ranges, both Centigrade and Fahrenheit.

If you have a control application where chart records are unnecessary or already provided for, then Bristol's Model 93 Free-Vane Air-Operated Controller is the instrument for you.

This small, compact instrument features the same precision measuring element used in all Bristol recording and controlling instruments, and the same high-sensitivity, frictionless Free-Vane control system used in all Bristol air-operated controllers.

Set-point adjustable to any value in the instrument range simply by turning pointer to desired value. Throttling range adjustable from ½% to 12% by the user.

Model 93 Controllers are offered for:

1. **Temperature** – from −125F to +1000F.
2. **Pressure** – from 0 to 10,000 psi.
3. **Liquid level** – in open or closed vessels.
4. **Flow** – of steam, gas, air or other liquids through pipes.

The Model 93 Air-Operated Controllers are described in complete detail in bulletin A115. Write for a free copy today. Also ask for our control valve catalogs. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 5.25

TRADE MARK BRISTOL'S REG. U.S. PAT. OFFICE

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

UTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **81** on inquiry card.

SPECIAL
JERGUSON
WELDING PAD GAGES
are *integral* part
of this tank

Welding Pad Gages staggered on tank for continuous visibility.

HERE is a special line of gages that weld right to the liquid containing structure, thus becoming an integral part of it. It solves problems where it is impractical for you to use a conventional type gage because of solids in suspension in a liquid, etc.

These Special Gages follow Jerguson Standard Gages in general design and materials, except for the method of attaching. The chamber of the gage consists of a bar steel pad which is welded to the vessel.

Welding Pad Gages are made in both Reflex and Transparent types . . . in all sizes of Jerguson Standard Gages. Pressure ratings are available to your specific requirements. Welding pad may be of any metal desired to withstand corrosive or other conditions.

Write for Data Unit on Welding Pad Gages for complete details. Whatever your gage problems, let Jerguson engineers assist you.

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Gages and Valves for the Observation of Liquids and Levels

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Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

For more information circle **82** on inquiry card.

pecially polio vaccine production; also an extra-large tubular unit, 1¾" diam and 10" long, available in all porosities. (3) New color-coded Pyrex brand pipettes, measuring and serological types, with red, yellow, blue, green, black, or white markings. (4) Pyrex brand precision bore tubing, 36" lengths, inside diameters from ⅛" to 1" held to tolerances of 0.0002".—*Corning Glass Works, Corning, N. Y.*

For more information circle **342** on inquiry card.

RECORDING SPECTROMETER

New single-beam recording prism-grating spectrometer provides excellent resolving power over entire infrared region (band separations of better than 0.8cm^{-1}), high energy per spectral slit width and freedom from scattered light. Major components: (1) source with related optics; (2) Littrow KBr-prism monochromator with transfer optics; (3) grating monochromator with wavelength drive, detection and recording systems. (Foreprism monochromator is available separately for conversion of maker's Prism Spectrometers to grating use.) Foreprism unit has advantage over optical filters, in that it eliminates both longer and shorter radiation from other grating orders, and provides much narrower spectral band pass. It is easily adjusted from one wavelength to another over a wide wavelength range. Using optional prism/grating combinations, effective range of instrument extends from ultraviolet to far infrared. Scattered light is less than 0.1% in NaCl region. Single- or double-pass grating operation can be provided.—*The Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **343** on inquiry card.

BENCH OR DESK MAT

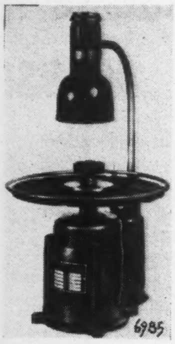
New "Guth Handi-Mat" provides chemical and mechanical protection to equipment and apparatus; is a

solid polyethylene sheet ribbed to give better cushioning and a surface on which glassware can be drained, dried and stored; can be easily washed and rinsed; is available in two sizes of ready-cut mats and in a utility roll.—*Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.*

For more information circle **344** on inquiry card.

SHOP EQUIPMENT

"VISIBLE" GRINDER



New bench grinder permits operator to see through wheel to keep workpiece surface under constant observation. New method, called "visible grinding" utilizes a specially-designed unbreakable slotted wheel which, when rotated at 3,600 rpm, becomes, in effect, transparent. Wheel rotates in a horizontal plane, so that sparks and dust are carried away from operator. Turbine-like slots in wheel air-cool both wheel and workpiece.—*Carl Hirschmann Co., Inc., Manhasset, N. Y.*

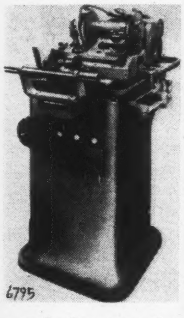
For more information circle **345** on inquiry card.

PRINTED CIRCUIT SCREENS

New ready-to-use silk screens for printed circuits are said to solve "several of the major problems faced by electronics manufacturers." Unique method of stretching silk on frame insures tautness, eliminates circuit distortion during length of production run. Maker guarantees exactness of reproduction of circuit on screen from schematics.—*NAZ-DAR Co.,* 461 *Milwaukee, Ave., Chicago* 10, *Ill.*

For more information circle **346** on inquiry card.

COPY GRINDING MACHINE



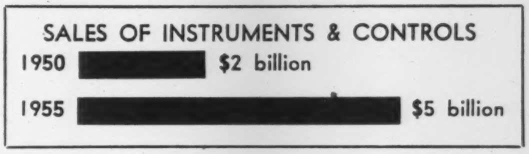
New "Copyrex" permits simultaneous grinding of two identical cutting tools, profile gages, or production parts. An easily-made template, 5 times tool size, effects copying process through a parallelogram linkage to twin holders. A pair of diamond dressers keeps wheels trued. ★ Cylindrical grinding attachment to permit grinding of circular pieces up to 4" dia is also available.—*Carl Hirschmann Co., Inc.,* 30 *Park Ave., Manhasset, N. Y.*

For more information circle **347** on inquiry card.

CASE MATERIAL

New "60 Case" is an entirely new type of industrial material, in long round hardened bars for use as

HELP YOURSELF TO A LARGER SHARE OF THIS GROWING MARKET



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INSTRUMENTS & AUTOMATION HANDBOOK & BUYERS' GUIDE is the *only* buying directory devoted *exclusively* to products and components in demand by this expanding instrumentation-automation market.

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PAID DISPLAY ADVERTISING in this directory can help you compete *more effectually* for a larger share of the market by pinpointing valuable preselection data such as: product characteristics and specifications, special features, availability, etc.

Use your ad space in one or more of these ways to get results:

(1) Include your complete general catalog,
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PRODUCTION ENGINEERS

JOIN THE LEADER IN AERO CONTROLS!

Honeywell needs top-notch Process Engineers at all levels of responsibility for directing the production of such *airborne* control systems as:

INERTIAL GUIDANCE
JET ENGINE CONTROL
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Engineers selected will analyze designs, establish process methods and control, and guide designs toward economical and speedy production.

■ To qualify, you should be familiar with process evaluation, cost estimating, tool ordering, metals fabrication, and manufacturing-assembly operations. Your background should be in the area of *precision* electrical, mechanical, or hydraulic devices such as gyros, accelerometers, operational computers, pressure switches, amplifiers, calibrators, altitude compensators, and thermistor level switches.

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■ Minneapolis offers you metropolitan living with a suburban way of life . . . A city of beautiful lakes with every recreational facility a few minutes from your home.

■ Outstanding educational opportunities . . . Liberal tuition allowances paid by Honeywell.

■ Plant and technical facilities among the best in the industry.

■ Honeywell pays your family moving expenses.

■ Salaries, insurance-pension programs are all first rate.

■ Honeywell, the nation's leading supplier of control systems, manufactures over 10,000 diversified products. A sound growth company, Honeywell offers continuing expansion and permanent opportunities for you to advance.

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If you are interested in a career at Honeywell, call collect or send your résumé to Bruce Wood, Dept. IA-5-108, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13.

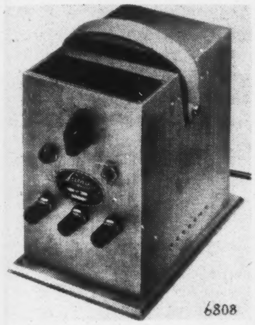
MINNEAPOLIS
Honeywell
First in Controls

shafts, rolls, rods, etc. Material is AISI 1060 Steel which has a surface hardness close to 60 Rockwell C and is precision ground to standard diameters. It is said that finished "60 Case" parts frequently cost less than scrap losses that result from conventional methods. Initial standard sizes range from ¼" to 4" nominal dia; depth of hardness from 0.040" minimum in smallest diameter to 0.100" minimum in largest.—*Thomson Industries, Inc., Manhasset, N. Y.*

For more information circle **348** on inquiry card.

RESISTANCE SOLDERING TOOL

New "No. 626" has a six-stage selector switch and three secondary terminals, providing 18 heat stages or 18 different voltages from 1.3 to 5.1; operates on 115 v 60 cps; power range 5 to 1800 watts.—*The Luma Electric Equipment Co., Toledo, Ohio.*


6808

For more information circle **349** on inquiry card.

ULTRASONIC CLEANER

New "Model C-375" cleaning assembly, semi-portable for bench work, is designed for use with organic solvents, or detergents; has a 3-gal stainless steel tank; 375-watt RF generator; combination solvent filtering and recirculation system operated by a ¼-hp motor; newly-developed ceramic titanate transducers.—*McKenna Laboratories, 2503 Main St., Santa Monica, Calif.*

6816

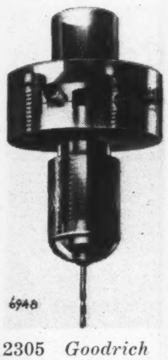
For more information circle **350** on inquiry card.

RHODIUM-PLATING SOLUTION

New "No. 221" solution designed specifically to produce heavier deposits with lower stress in a shorter time plates up to 0.001" in 70 minutes. It can be used without modification of present equipment. Deposit produced from this bath is extremely useful in many electrical and electronic applications: low noise level for moving contacts, no oxide rectification, low and stable contact resistance, etc.—*Baker & Co., Inc., Newark, N. J.*

For more information circle **351** on inquiry card.

ADJUSTABLE COLLET CHUCK

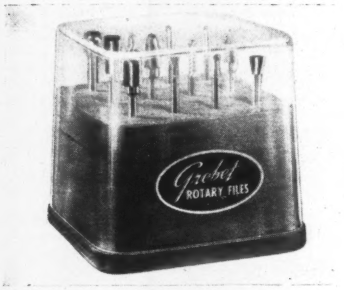

6948

New "Micro Collet Chuck" holds small tools concentric to drill spindle. Once alignment is made, it is not necessary to re-align chuck after new drills are put in. Available with two collets, for diameters 0.005" to 0.025", and for diameters 0.020" to 0.040".—*Detroit Cam & Tool Co., 2305 Goodrich Ave., Ferndale 20, Mich.*

For more information circle **352** on inquiry card.

ROTARY FILE BOXED SETS

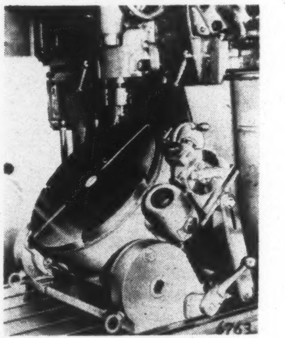
New rotary file sets come in wood-base boxes with transparent hard plastic top; include the most popular shapes and sizes, ⅛" or ¼" shank, chisel-cut and ground-from-the-solid types, high-speed steel and tungsten carbide.—*Grobet File Co. of America, Inc., Carlstadt, N. J.*



For more information circle **353** on inquiry card.

CIRCULAR TABLE

New "Microptic" (made in England) is said to combine "the mechanical skill of Coventry Gage and Tool,

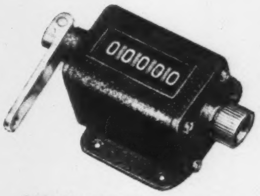

6763

See this "Show-Case" of VEEDER-ROOT COUNTERS... at your Industrial Supply Distributor

Useful "facts-in-figures" on practically every machine, operation, system or process in industry can be supplied by Veeder-Root Counters for mechanical, electrical and manual operation. And now Veeder-Root Counters can be supplied from stock by certain leading Industrial Supply Distributors. Find out from your own distributor how they can add to the efficiency and *Count*rol of your plant operation. And if you are selling or designing equipment, contact Veeder-Root for engineering recommendations.

Insist on Standard VEEDER-ROOT COUNTERS

from your Industrial Supply Distributor or write us on special problems

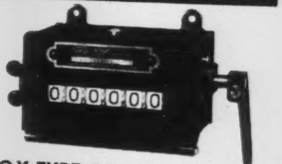


SMALL RESET COUNTER

A compact, rugged reset counter for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.

Dimensions: 1¾" long, 1$^{19}/_{64}$" high, 1$^{7}/_{16}$" wide

Speed: Up to 1000 counts per minute.



BOX-TYPE RESET COUNTER

For punch press installations, conveyors, metal-working equipment, die casting, plastic-molding, rivet, spring and wire machining, or any installation requiring a heavy duty counter.

Dimensions: 4¼" long, 2$^{5}/_{32}$" high, 3⅜" wide.

Speed: 500 counts per minute.

RESET MAGNETIC COUNTER

For remote indication of machine operation from plant to office.

Dimensions: 3$^{15}/_{16}$" long, 2½" high, 1⅝" wide.

Speed: Up to 1000 counts per minute.

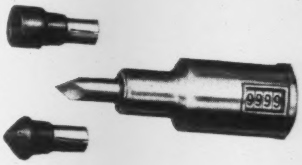
Coils: 110V-AC are standard. Other voltages are available. Panel mounting feature also available.

HAND TALLY

For quick spot-checks of production or performance.

Dimensions: 1$^{17}/_{64}$" long (to end of reset knob), 1¾" deep, 2" high.

Counts one for each depression of the thumb lever, and resets to zero by a turn of the knob.



CLUTCH SPEED COUNTER

For checking to make sure that the machine is operating at the required R.P.M.

Dimensions: 3¼" long, ⅞" max. diameter. Non-Reset.

Internal clutch operates counter only when rubber tip is pressed against the shaft.

Everyone Can Count on

VEEDER-ROOT

"The Name that Counts"

HARTFORD 2, CONN.

Stocked at Hartford 2, Conn. • New York 19, N. Y.
Greenville, S. C. • Chicago 6, Ill. • Montreal 2, Canada
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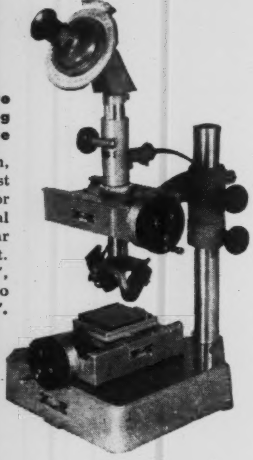
For more information circle **83** on inquiry card.



Coordinate Measuring Microscope

High precision, low cost instrument for 2-dimensional linear measurement. Range 2" x 2", reading to 0.0001".

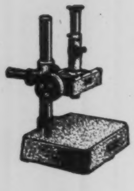
Cut rejects, speed production

Fast, reliable readings to 0.0001" with Gaertner measuring microscopes

Precise, versatile, easy-to-use Gaertner measuring microscopes assure positive, direct measurement of precision parts. You see clear, sharply-defined images. No physical contact to distort or injure object being measured. Enjoy new production savings with Gaertner optical instrumentation. Write for complete data on the Gaertner line of industrial microscopes.

Toolmakers' Microscope

Ultimate in measuring microscopes. Range 2" x 4", reading to 0.0001", angular measurement to 1 minute.



Micrometer Slide Comparator

Reliable, low cost instrument for linear measurement. Ranges up to 4", reading to 0.0001" or 0.00005".

Filar Micrometer Microscope

High quality, low cost instrument for extremely precise measurements. Range 0.08", reading to 0.00002".

Write for Bulletin 161-54 showing applications, models, specifications.

The Gaertner Scientific Corporation

1211 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

For more information circle **84** on inquiry card.

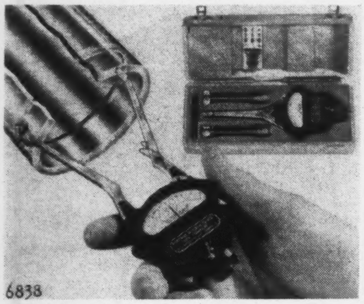
and the optical know-how of Hilger & Watts, to produce the finest circular table available." Optical micrometer divides 10-min divisions on main glass circle into 200 parts, to give a direct reading to 3 sec. Provisions are available for mounting t an inclinable table for which inclina- tions are controlled by a "Micropti Precision Clinometer" reading direct- ly to 10 sec with estimation to 3 se —*Engis Equipment Co., 431 S. Dear- born St., Chicago 5, Ill.*

For more information circle **354** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

GROOVE CHECKING GAGE

New Swiss-made "InterRapid Groove Checking Comparator Gauge" has capacity ⅜" to 6" dia and serrated hinge joints to keep tips parallel on wide measurements; is graduated in 0.0005"; gives accurate 3-point checking for production runs, or 2-point checking for short runs.—*Portage Double Quick Tool Co.,* 1081 *Sweitzer Ave., Akron, Ohio.*

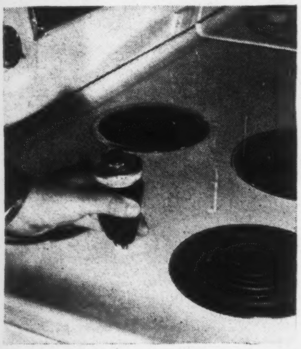


6838

For more information circle **355** on inquiry card.

THICKNESS GAGE

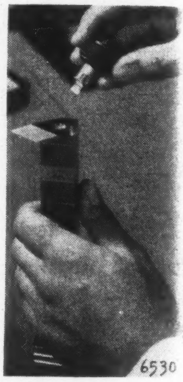
New "Permanent-Magnet Thickness Gage" requires no power, yields quick, accurate, non-destructive measurement of thickness of nonmagnetic materials bonded to smooth iron or steel; will also measure thickness of nonmagnetic materials which can be placed over a magnetic reference plate; has two ranges (0.001" to 0.060" and zero to 0.007"), calibration adjuster, adjustable limit pointers, four reference thickness standards, leather carrying case. Accuracy is ±5 to ±10% within 50% of calibration point.—*Instrument Dep't, General Electric Co.,* 40 *Federal St., West Lynn* 3, *Mass.*



For more information circle **356** on inquiry card.

TORQUE SCREW DRIVER FOR GAGE-BLOCK ASSEMBLIES

New torque screw driver has been added to maker's line of square gage blocks and system of accessories. For assembling square gage blocks into working gages, tie rods are passed through holes in center of blocks and stack is clamped by means of screws which fit internal threads at each end of tie rods. Tightening with a ordinary screw driver can cause e ror. New screw driver "slips" at fixed torque, is intended for use afte blocks have been cleaned and wrun to achieve consistent repeat accurac —*The DoAll Co., DesPlaines, Ill.*



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For more information circle **357** on inquiry ca

TOOLMAKER'S FLAT AND CASE

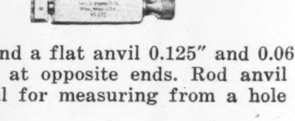
New black granite surface plate for bench use is 8x12x2"; weighs 1 lbs; over-all accuracy 0.0002". Carrying case has detachable cover, enabling use of flat without remova from case.—*Collins Microflat Co 2326 E. 8th St., Los Angeles, Cali*

6754

For more information circle **358** on inquiry ca

MICROMETERS

New "No. 220 Mul-T-Anvil" mi crometers feature two interchange able anvils: a rod anvil about 0.120 dia and a flat anvil 0.125" and 0.060 thick at opposite ends. Rod anvil i useful for measuring from a hole to



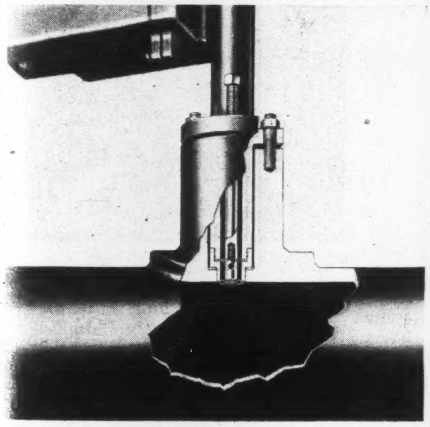
***Another Swartwout Development in Instrumentation for Better Quality Control**

SWARTWOUT
AUTRONIC CONTROL SYSTEMS

Precise pressure measurement without line impedance or temperature effects . . . without filled systems—that's the new Swartwout P3T Flush Diaphragm Pressure Transmitter*. And since this new pressure transmitter eliminates heat jacketing or tracer lines . . . stagnant pressure lines or fluid seals, it's ideal for use with such hard-to-handle fluids as asphalts, high-temperature or viscous liquids, molten metals, slurries and polymers. The P3T pressure transmitter operates in process temperatures up to 1200°F . . . has sensitivity of .005%, reproducibility of .1%, accuracy of 1%. Standard units for ranges up to 10,000 psig, higher pressures on special order. Full details on request to your Swartwout representative, or request Bulletin A-713.

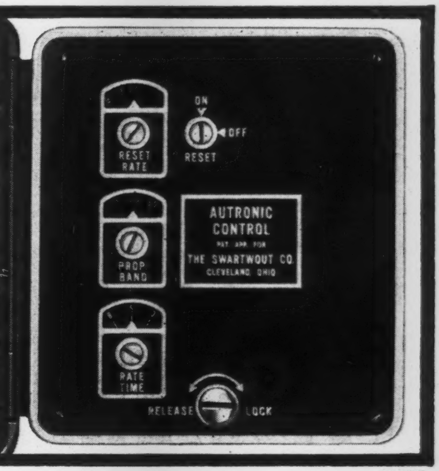
New flush diaphragm pressure transmitter

eliminates stagnant pressure lines without heat jacketing



◀ **Cutaway section** shows how pressure acts against diaphragm mounted flush with inside of process pipe. Force is transmitted through rod to amplifying linkage which moves core of a differential transformer, transmits an electric signal to Autronic Controller or Recorder.

Autronic Controller or Recorder is used with P3T Flush Diaphragm Transmitter. Signal from pressure transmitter is directly proportional to pressure being measured. Since no slide wires, boosters, motors, etc., are used, response of the Autronic System is instantaneous and accurate. ▶

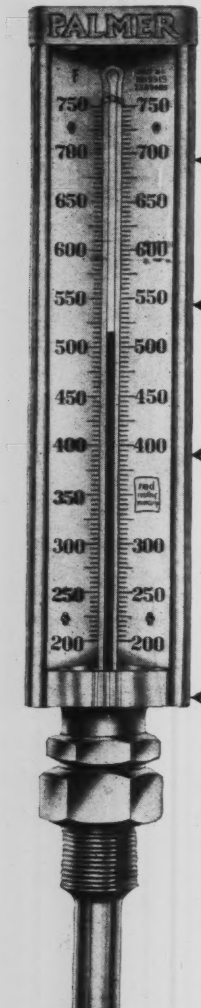


AA-1342

Swartwout Autronic® CONTROL SYSTEM

HE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

For more information circle **85** on inquiry card.



Today's Modern Industry
Demands a Modern Thermometer

PALMER

RED-READING MERCURY THERMOMETERS

Red-Reading
Mercury

Extruded
Brass Case

Chrome
Finish

Ranges
-40 to 950°F
or
Equivalent
in °C

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Complete
Information
Ask for
Bulletin No. 35

Consult your
Classified Directory

PALMER
THERMOMETERS, INC.
Mfrs. of Industrial Laboratory,
Recording and Dial Thermometers
Cincinnati 12, O.

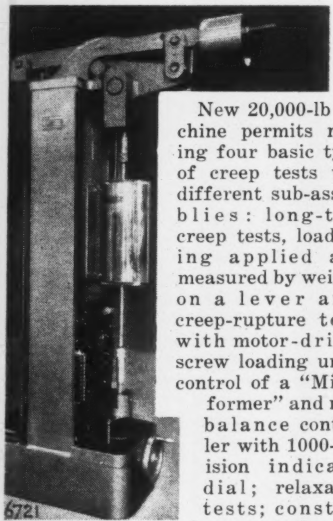
For more information circle 86 on inquiry card.

an edge. With flat anvil, distances from inside of slots and grooves to an edge can be conveniently measured. Additional anvils of various shapes can be made up by anyone and do not necessarily have to be hardened for occasional special jobs. Available in two sizes with ranges of 0 to 1" and 1" to 2".—*L. S. Starrett Co., Athol, Mass.*

For more information circle **359** on inquiry card.

MECHANICAL TESTING

CREEP TEST MACHINE

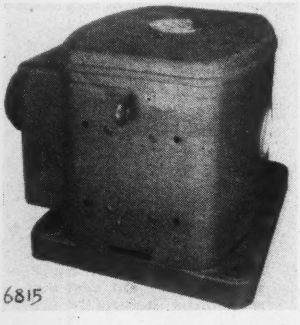


New 20,000-lb machine permits making four basic types of creep tests with different sub-assemblies: long-time creep tests, load being applied and measured by weights on a lever arm; creep-rupture tests with motor-driven screw loading under control of a "Microformer" and null-balance controller with 1000-division indicator dial; relaxation tests; constant strain-rate tests. Improved furnace provides for tests up to 1800°F.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **360** on inquiry card.

TORSIONAL CALIBRATOR

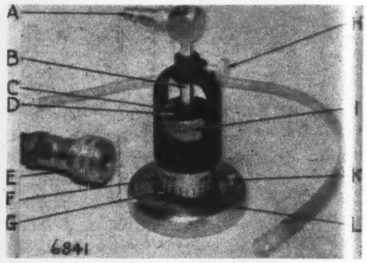
New "Model CA1050," though designed primarily as a calibrator for torsional pickups, rate gyros, etc., is suitable also for testing relays, checking torsional frequencies and exciting torsional modes in small rotating units. It can produce torsional oscillations without resonances in moving element to frequencies as high as 1600 cps under free-table no-load conditions. A generated torque of 110 lb-ft permits rotational acceleration up to 1570 radians/sec^2 with no table load. —*Engineering Dept., MB Mfg. Co., 1060 State St., New Haven, Conn.*



For more information circle **361** on inquiry card.

RUBBER SEALING TESTER

New Rubber Pressure Sealing Test Jig is designed for evaluation of sealing properties of rubber and rubber-like materials by ASTM test method D 1081; also to simulate service behavior according to MIL-R-900A.—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

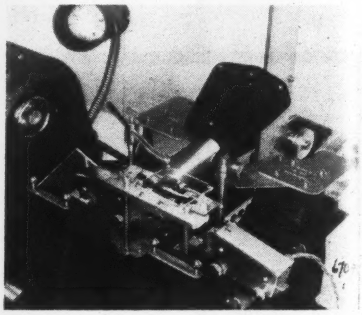


A. air inlet; **B.** plunger; **C.** cup; **D.** disc sample; **E.** air coupling; **F.** canopy; **G.** anvil; **H.** plunger lock screw; **I.** sample holder; **K.** canopy lock screw **L.** base.

For more information circle **362** on inquiry card.

BALANCING MACHINE FOR EXTRA-SMALL ROTORS

New "M2-S-40/AA Dynograph Balancing Machine" is designed for balancing miniature rotors "which are so small as to be beyond the range of ordinary balancers now on the market." Rotors weighing a small fraction of an ounce can be balanced on a production basis.—*R. B. Annis Co., 1101 N. Delaware St., Indianapolis, Ind.*



For more information circle **363** on inquiry car

PORTABLE OVEN

New general-purpose portable ove features a recirculating heating sys tem and positive automatic tempera ture control. Six models available fo

Announcing the top Automation Education Program of the Year

—100 CLINIC CLASSES

AUTOMATION promises wonders for the future—but today there is a lack of trained manpower—there are not enough men available who are trained to work and think in the area of automatic production.

Manufacturers of automatic controls are faced with this problem in the application of their products in industry. Industrial executives cannot spare their engineers and production men the time to attend colleges and universities. Now—for the first time—a complete educational lecture-demonstration program is offered as a solution to these problems.

The Automation Show Management therefore offers

100 CLINIC SESSIONS

in conjunction with the THIRD INTERNATIONAL AUTOMATION EXPOSITION, November 26-30, 1956, New York, in the fields of

- (1) Electronic Computers
- (2) Process Automation
- (3) Machine Tool Automation
- (4) Office Automation
- (5) Automatic Materials Handling (conveyors)
- (6) Servomechanisms
- (7) Electromechanical Components
- (8) Electronic Components

Each clinic class will comprise a 90-minute *lecture and demonstration* based on *operating equipments* exhibited at the Exposition.

Each registrant can sign up for six clinic sessions in one (or more) of the eight basic fields.

For example, registrants to the Computer Clinic of the Second International Automation Exposition chose six of the following nine classes:

1. The Austin Co. (special-purpose computers)
2. Clevite-Brush (TapeDrum data handling)
3. Bendix Aviation (digital differential analyzers)
4. Berkeley-Beckman (analog computers)
5. Goodyear Aircraft Co. (analog computers)
6. Electronic Associates, Inc. (analog computers)
7. International Business Machines (digital data processors)
8. Librascope, Inc. (digital computers)
9. Teleregister Corp. (Magnetronic data systems)

Fill in card for early registration. Only 200 persons can be accommodated for any one field—for example, only 200 persons will be accepted for the computer clinic. Early registration is advised. Fee is $10.00 for six sessions. Each registrant will be given a choice of six sessions from the 100 available.

These clinic presentations will be at the applications level and thus instruct engineers, research men and technicians to specify, apply, and operate the components and equipments now available for plant, factory, laboratory and office automation.

Each clinic will consist of one 90-minute lecture and demonstration, by each of the participating firms, to a class of 30-35 registrants. This session will be delivered up to six times in order to ultimately reach the 200 registrants that will be accepted for any one clinic.

Third International Automation Exposition, Advance Clinic Registration
845 Ridge Ave., Pittsburgh 12, Penna.

Please expedite my registration for six clinic classes.
Attached is my $10 registration fee ☐. Please send more details ☐.

I prefer them to be in the field of ....
or divided between the fields of ....

Name ....

Company .... Title ....

Address ....

Products Manufactured ....

MEASUREMENTS' MEGACYCLE METER

Gives You Extended Coverage from 100 Kc to 940,000 Kc

PRECISION GRID-DIP METERS

MODEL 59
Power Supply
$75.00

MODEL 59-LF OSCILLATOR UNIT

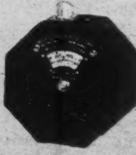
Frequency Range:
100 Kc to 4.5 Mc.
Price - Oscillator Unit (Head) only $98.50
with Power Supply
$168.00

MODEL 59 OSCILLATOR UNIT

Frequency Range:
2.2 Mc to 420 Mc.
Price - Oscillator Unit (Head) only $98.50
with Power Supply
$168.00

MODEL 59-UHF OSCILLATOR UNIT

Frequency Range:
420 Mc to 940 Mc.
Price - Oscillator Unit (Head) only $123.00
with Power Supply
$198.00

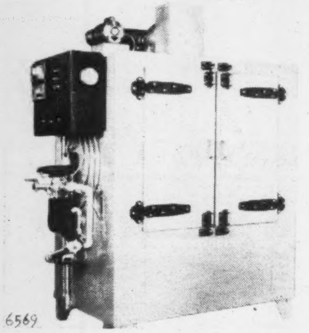


Measurements' Megacycle Meter is now available in a choice of three oscillator heads providing frequency range coverage from 100 Kc to 940,000 Kc. Thus, the utility of this versatile instrument has been extended, making it, more than ever, indispensable to anyone engaged in electronic work; engineer, serviceman, amateur or experimenter.

Laboratory Standards

MEASUREMENTS CORPORATION
BOONTON • NEW JERSEY

For more information circle **87** on inquiry card.

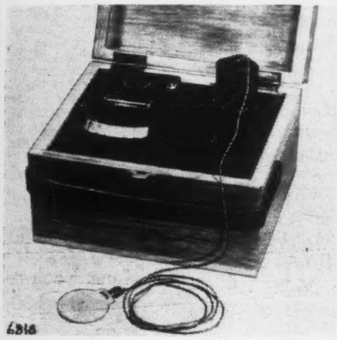


immediate delivery; ranges from 500° F to 1000°F; oven sizes from 20x20x-20" to 26x38x50".—*The Carl Mayer Corp., Dept. F, 3030 Euclid Ave., Cleveland 15, Ohio.*

For more information circle **364** on inquiry card.

HEAT-FLOW MONITOR

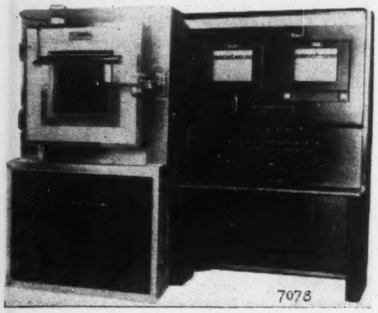
New "HFG-2 Heat-Flow Monitor" utilizes maker's "Heat-Flow Discs," reads directly in BTUs heat-flow through any surface in contact with discs. Ranges 0-30, 0-60, 0-300, and 0-600 Btu/ft^2 hr.—*National Instrument Labs. Inc., 6108 Rhode Island Ave., Riverdale, Md.*



For more information circle **365** on inquiry card.

INSTRUMENT CONSOLE FOR TEST CHAMBERS

New instrument console, adjunct to maker's environmental equipment (shown with flight chamber "12-STR") has all switches, dials, and contacts mounted on front for easy control and more accurate operation; can be located remotely for any operation which involves danger; is available in many sizes and types to fit needs of users of environmental test equipment of any make.—*Tenney Engineering, Inc., 1090 Springfield Road, Union, N. J.*



For more information circle **366** on inquiry card.

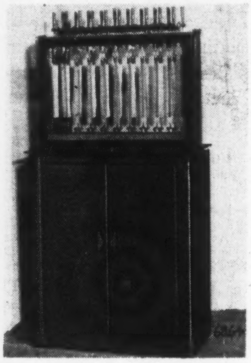
LEAK DETECTOR

New "Radiflo" is said to be "the first non-destructive, atomic energy leak detection system for testing hermetically sealed parts and containers." Nominal sensitivity 1 cc per 500 years. Large numbers of parts can be radiated or immersed and cleaned simultaneously: over 50,000 parts can be tested per month on a single shift basis.—*American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.*

For more information circle **367** on inquiry card.

PAPER EXPANSIMETER

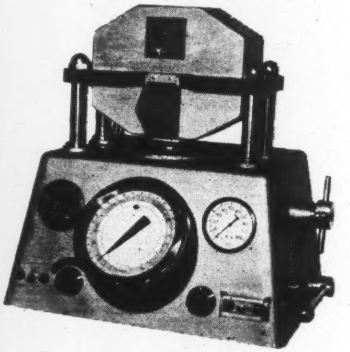
New "Neenah Multiple Specimen Paper Expansimeter" is production model of instrument whose development and proof in practice has taken sixteen years. Original equipment and methods were developed at The Institute of Paper Chemistry, Appleton, Wis.—*The Martin Sweets Co., 114 S. 1st St., Louisville 2, Ky.*

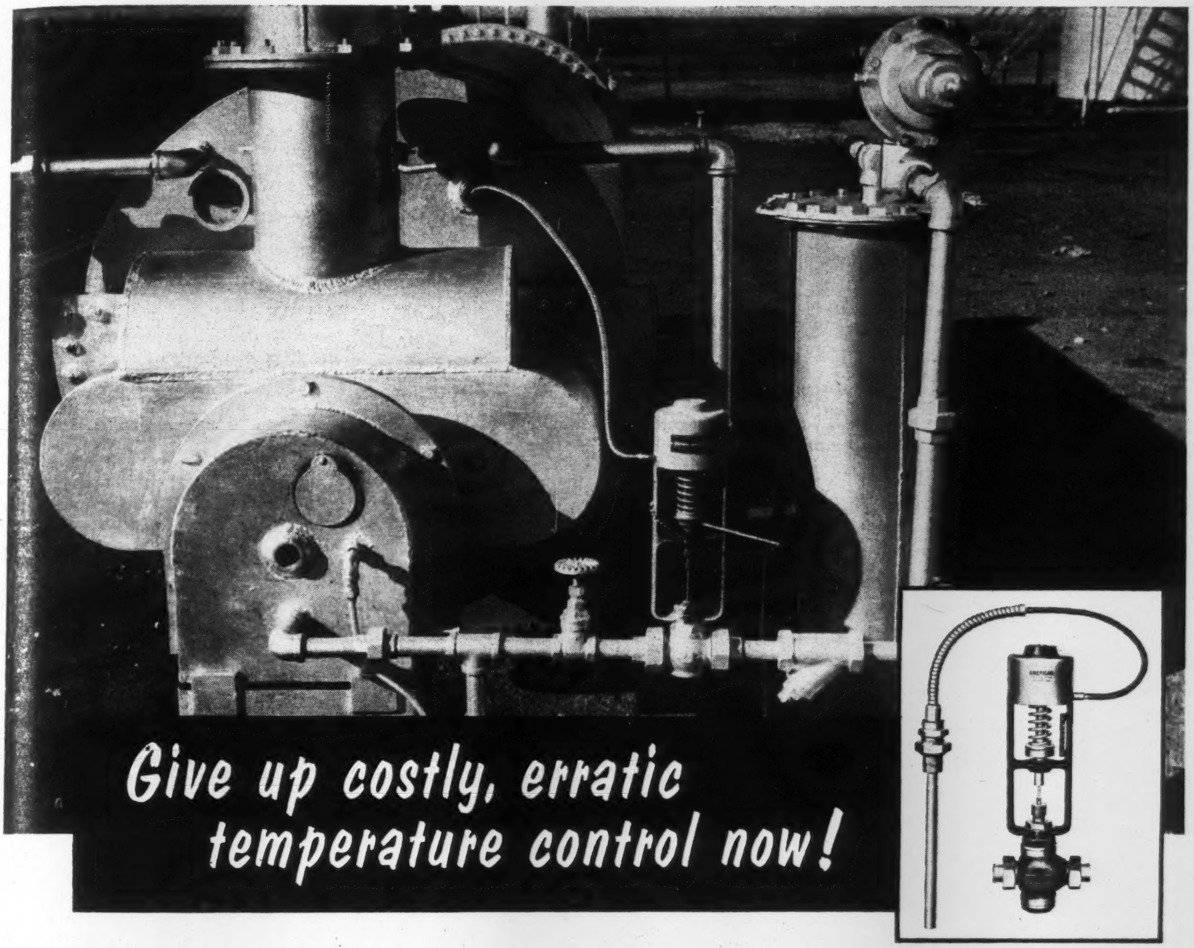


For more information circle **368** on inquiry card.

PRINTING SMOOTHNESS TESTER

New "Model 55" utilizes principle conceived by S. M. Chapman: while paper specimen is under a compres-





INSTALL 'AMERICAN' TEMPERATURE REGULATORS

Oil heaters and treaters . . . water heaters . . . diesel water jackets . . . dryers . . . ovens . . . plating tanks . . . washers . . . feedwater systems . . . air-compressor after coolers. Equipment of all kinds in all kinds of industries is seldom kept at required temperatures *when operated manually.* Result: a lot of money wasted every day.

Eliminate costly, erratic manual control—now! Get reliable overheat protection. American Temperature Regulators do a far better job than even the most skilled operators. They are self-operated, automatic—constantly maintain temperatures within required limits. Greater product uniformity is assured. Fuel and manpower are saved. Users find these sturdy, powerful regulators often pay back their cost 3 to 6 times a year. Many serve dependably 10 to 25 years!

Boost efficiency and economy wherever accurate temperature control is an everyday necessity. American Temperature Regulators are sensitive and responsive. Installation is simple. No compressed air or electricity needed. Temperature adjustment and repeat setting are easy. Sizes range from ¼" to 4". Get complete details. Write for Bulletin 112C.

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AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **88** on inquiry card.

sive load which corresponds to platen pressure of a printing press, instrument electronically measures areas in optical contact with a glass prism and gives direct reading of Chapman "F" value. Standard measurements of printing smoothness are positively correlated between instruments regardless of distance between instrument locations.—*Allegany Instrument Co., Inc.*, 1091 *Wills Mountain, Cumberland, Maryland.*

For more information circle **369** on inquiry card.

ELECTRICAL TESTING

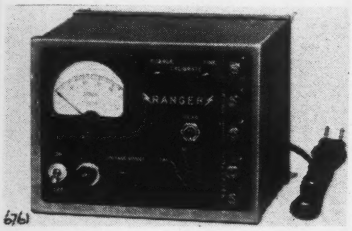
SWEEPING OSCILLATOR

New "Marka-Sweep Model Video 50" provides both a 50-Mc sweep which includes low end of video spectrum, and a continuously variable IF frequency sweep; has both internal and external crystal-controlled pulse-type markers.—*Kay Electric Co.*, 14 *Maple Avenue, Pine Brook, N. J.*

For more information circle **370** on inquiry card.

CAPACITANCE TESTER

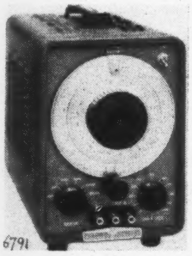
New "Ranger Model TR-102-A," for use with a time interval meter, is essentially a comparator; measures capacitor under test against a built-in standard and value of capacitance is read directly in microfarads on time-interval meter. Reading rate 30/min; range 0.01 to 10 uf.—*Electronic Specialty Co.*, 5121 *San Fernando Rd., Los Angeles* 39, *Calif.*



For more information circle **371** on inquiry card.

6-CPS TO 6-KC OSCILLATOR

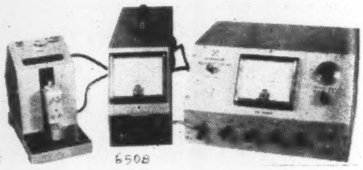
New "Model 200J Interpolation Oscillator" is designed for measurements where frequencies must be known with extreme accuracy. A 6" tuning dial, in combination with six ranges, results in an 80" effective scale length. Calibration accuracy 1% over frequency range from 6 cps to 6 kc. Output 160 mw or 10 v into 600 ohms, or 20 v open circuit—*Hewlett-Packard Co.*, 275 *Page Mill Rd., Palo Alto, Calif.*



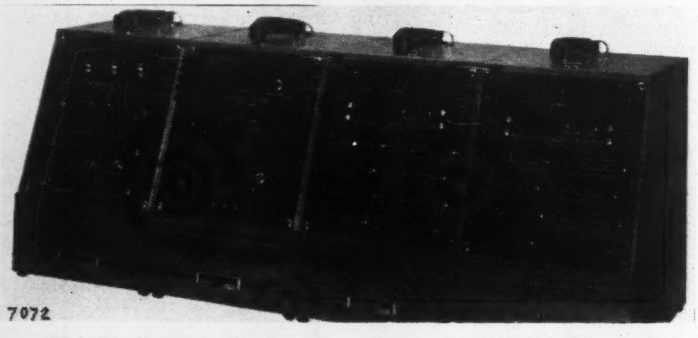
For more information circle **372** on inquiry card.

SEMICONDUCTOR TESTER

New "Model JN1 Semiconductor Resistivity Test Set" is especially designed to measure resistivity of ger-



ELECTRICAL EQUIPMENT ANALYZER



New "SA-55 Systems Analyzer" comprises three testers which work as one system or can be used individually: (1) "CT-55 AC Bridge Comparative Tester" compares capacitors, resistors, inductors, or combinations, against standards. (2) "HP-55 Hi-Pot Tester" gives a selection of 300, 600, 1000 and 1500 vdc at 10 ma; can detect leakage as high as 400 megohms. (3) "AD-55 Circuit Selector" will select two complete independent circuits at one time, has a total of 50 selections per unit. A chassis known to be good can be used as a reference. Number of circuits to be compared is not limited, as additional 50-circuit Selectors can be used.—*Technical Development Corp.*, 4060 *Ince Blvd., Culver City, Calif.*

For more information circle **373** on inquiry card.

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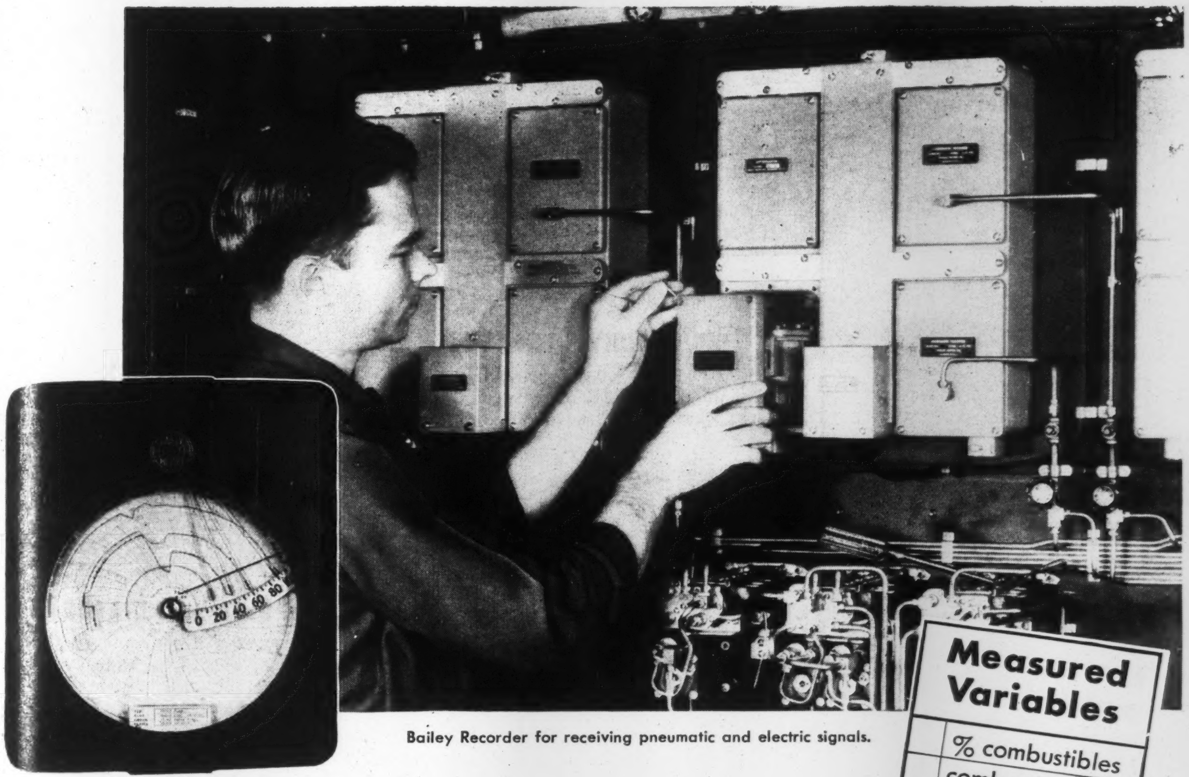

Bailey Recorder for receiving pneumatic and electric signals.

Measured Variables

☐ % combustibles
☐ combustion
☐ conductivity
☐ density
☐ differential
☐ draft
☐ flow
☐ liquid level
☐ % oxygen
☐ pH
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☐ smoke density
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Here is a receiver recorder, custom-built *by you* to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

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Ask for Product Specification E12-5.

P33-1

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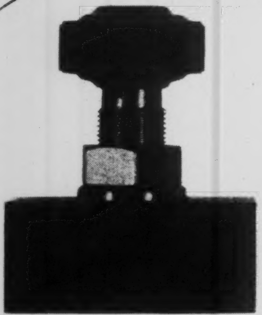

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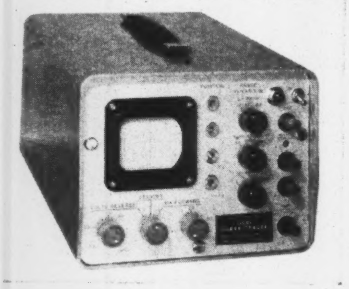
manium samples but its probe assembly can also be adapted for silicon. Range: 0.1 to 100 ohm-cm; feature: "four-point-probe" method for precise testing of semiconductor resistivity. Major components: (1) "Model JP1 Probe Assembly," (2) "Model JQ1 Germanium Resistivity Test Unit," (3) null detector.—***Baird Associates,*** *Inc.* 33 *University Rd, Cambridge* 38, *Mass.*

For more information circle **374** on inquiry card.

DIODE-CURVE TRACER

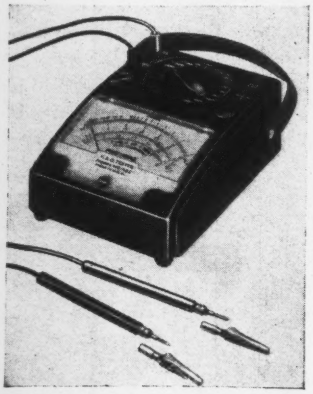
New "Model 1003B" provides independent display of forward and reverse characteristics of all common types of diodes, gives an image four times that obtained with earlier models. (For more detailed display, easy connection to large lab CROs.) Dual inputs permit convenient comparison or differential testing of diodes and resistors: production testing use in addition to lab and maintenance.—*Waters Mfg., Inc., P.O. Box* 368, *South Sudbury, Mass.*



For more information circle **375** on inqiury card.

OVERLOAD-PROOF TESTER

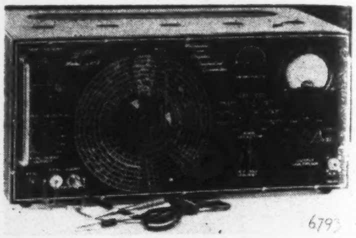
New "Model 455 V.A.O. Tester" features an automatic overload protection system. Accidental overloads will open input circuit: it is then necessary only to press red reset button and proceed again with instrument set for proper function and range. —*The Martindale Electric Co.,* 1360 *Hird Ave., Cleveland* 7, *Ohio.*



For more information circle **376** on inquiry card.

ALL-BAND GENERATOR

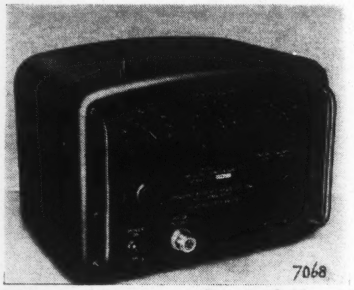
New "Model 295X Microvolt and Crystal Controlled Generator" meets military requirements and is designed primarily to service receivers in mobile and aircraft fields. Sensitivity, selectivity and frequency of a receiver can be readily determined with extreme accuracy, and without use of correction factors or reference tables. —*The Hickok Electrical Instrument Co.,* 10528 *Dupont Ave., Cleveland* 8, *Ohio.*



For more information circle **377** on inquiry card.

IMPULSE GENERATOR

New "91263-1 Impulse Generator" will find an unusual number of uses including bandwidth determination, testing noise-suppression methods and devices, receiver alignment, etc. Spectral intensity is flat within ±0.5 db over frequency range of 10 kc to 1000 Mc. Maximum output of 101 db above 1 uv/Mc is adjustable in ¼ db steps from 10 db to maximum. Repetition rate is sixty 0.0005-usec pulses per second.—*Stoddart Aircraft Radio Co., Inc.,* 6644 *Santa Monica Blvd., Hollywood* 37, *Calif.*



For more information circle **378** on inquiry card

NOISE GENERATOR

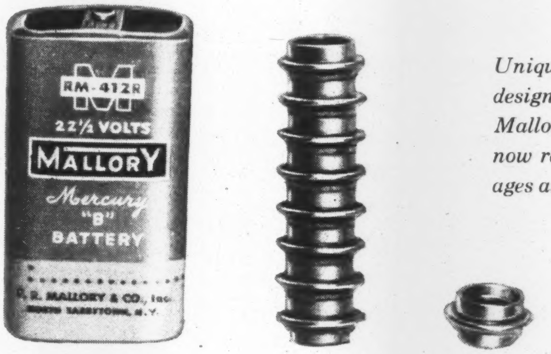
New completely-transistorized portable (under 6 lb) noise generator for testing electronic systems introduces random noise to determine signal-to-noise ratio; can be operated either from 110-v line or from standard flashlight batteries.—*Universal Atomics Corp.,* 19 *E.* 48*th St., New York* 17, *N. Y.*

For more information circle **379** on inquiry card.

RANDOM PULSE GENERATOR

New completely transistorized portable (under 6 lb) random pulse generator for use in radiation and electronic laboratories, and for field test-

MALLORY



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New Mallory mercury batteries are supplied in 15, 22½ and 45 volt ratings, in the same case sizes as standard carbon miniature batteries. They can also be made readily in other voltages and case sizes, to your own requirements. For complete data, write or call Mallory today.

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For more information circle **92** on inquiry card.

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Tape Recorder

Height: 5"—Diameter: 4"

Weight: 4½ lbs.

Eight channels of information can be applied simultaneously to a ½-inch tape in the Model MR-1 Recorder (illustrated). This self-contained unit includes transistor timing oscillator and battery power source and operates under axial accelerations up to 500 g. A pre-record carrier system permits direct coupling with D.C. devices such as thermocouples and strain gauge transducers.

MODEL MR-1 SPECIFICATIONS:
Accuracy:..................±5% full scale
Sensitivity:....28 millivolts D.C. full scale across 40 ohms impedance
Frequency Bandwidth:..........0-250 cps
Timing: ......1000 cps transistor oscillator
Running Time:................45 seconds
Applications: ....Running time, number of channels and recording characteristics are adaptable to meet requirements of applications—including rocket and aircraft flight testing, oil well logging and atmospheric studies.

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Telemeter transmitter converts DC mv from thermal converters, etc. to 10-30 cps which frequency modulates an audio tone channel. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed. Any communication link, including power line carrier, may be used. Overall accuracy is 1% with a response speed of 1 sec.

Other terminals for teletype, voice-plus-control & data transmission are available.

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Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

For more information circle **94** on inquiry card.

ing of radiation detectors and ratemeter circuits, can be operated either from 110-v line or from standard flashlight batteries.—*Universal Atomics Corp., 19 E. 48th St., New York 17, N. Y.*

For more information circle **380** on inquiry card.

SWEEPING OSCILLATOR

New "Sona-Sweep Model TV" keyed sweeping oscillator, for precision measurements at low end of video TV band, features separate controls on sync pulse and sweep generator RF output and adjustable equalizer for better than 0.5% accuracy in any one region in band. Blanking is added to provide zero level base line; permits locking of 'scope at test receiver end. Output is attenuated in steps for all of sync and sweep pulse signal. A frequency vernier control permits observation of specific portions of spectrum when sweep is turned down to narrow range.—*Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.*

For more information circle **381** on inquiry card.

COMBINED S & S GENERATOR

New "Sweepalator" is a double-duty unit which serves as a signal generator and as a sweep generator.

Range 10 kc to 1.5 Mc; 1-kc steps in 3 decades; interpolation calibrated 0-1 kc; accuracy 100 cps; short-term stability 25 cps.—*Decade Instrument Co., Box 153, Caldwell, N. J.*

For more information circle **382** on inquiry card.

DUAL TRACE GENERATOR

New "Model 600A" converts any standard oscilloscope to a dual input unit by chopper sampling two inputs at a 60-cps rate: two signals appear simultaneously on scope, with vertical separation between them adjustable by a control on "Model 600A."—*Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.*

MODEL 600A DUAL TRACE GENERATOR
Electro-Pulse, Inc.
CULVER CITY, CALIFORNIA
TRACE SEPARATION
INPUT
A
B
OUTPUT
A+B
AC OFF
6758

For more information circle **383** on inquiry card.

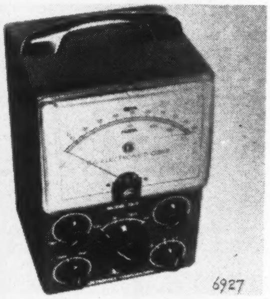
TRANSCOND'CE ANALYZER AND CIRCUIT DESIGNER

New "Model 901A" is a self-contained unit for measuring transconductance and plotting static operating conditions as well as developing vacuum-tube circuits quickly by means of color-coded pushbutton switching. Pushbutton matrixing switch arrangement permits rapid connection of tube elements to power supplies. Panel terminals allow insertion of components and special voltages so that circuits may be designed right on instrument. "Model 901A" also performs transconductance, voltage, current, shorts, continuity, leakage and gas tests of JAN-1A and MIL-E-1B Tubes.—*New London Instrument Co., 31 Union St., New London, Conn.*

For more information circle **384** on inquiry card.

TRANSISTOR TESTER

New portable "Model TR-2" provides a fast comparative check on *p-n-p* and *n-p-n* transistors for lab, production line, and radio service; is completely transistorized and less complex to operate than an ordinary tube tester; has two ranges allowing operator to read alpha, beta, and Ico directly; is available in ac or dc versions.—*CG Electronics Corp., 212 Durham Ave., Metuchen, N. J.*



For more information circle **385** on inquiry card.

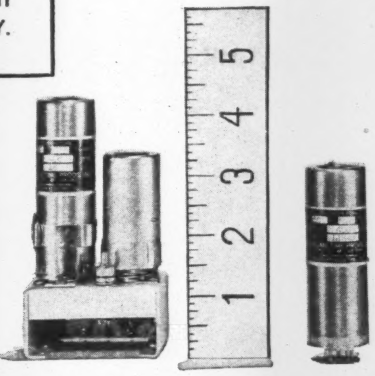
SIGNAL SIMULATOR

New "Model 20C" portable 400-cps suppressed-carrier modulated-signal generator is specifically designed for use under adverse flight line conditions for quickly checking aircraft or missile autopilots, etc. Rotation of a single knob on front panel selects any one of several calibrated steady-state or sinoidally-modulated signals. Either static or dynamic autopilot gains can be adjusted. Typical servo characteristics which can be easily

SIGNAL SIMULATOR
OFF
OUTPUT SELECTOR
7015

Another "New"

TYPE 50C, LEFT
TYPE 50, RIGHT
240 TO 800 CY.



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Introduced here are miniature versions of our popular Type 2003. They have equivalent accuracy but are much smaller, lighter and have fewer component parts. In the Type 50, all critical components are housed within the fork container.

Both the Types 50 and 50C offer superior shock resistance, up to 60 G. Hermetically sealed and shielded.

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SIZE....2¼" x 2" x 4⅜" high. WEIGHT....8 ozs.
ACCURACY............±.02% from —65° to 85°C
OUTPUT.............................5V into 250,000 ohms
TYPE R50C......................Same as Type 50C with accuracy of ±.002% from 15° to 35°C

PICTURED AT RIGHT, ABOVE

TYPE 50 SPECIFICATIONS

SIZE....1" dia. x 3¾" high. WEIGHT....3.5 ozs.
ACCURACY............±.02% from —65° to 85°C
OUTPUT.............................5V into 250,000 ohms
TYPE R50..........................Same as Type 50 with accuracy of ±.002% from 15° to 35°C

For 17 years this company has produced precision frequency standards for integration in highly accurate instruments and timing devices of our own and other manufacture. We make frequency standards within a range of 30 to 30,000 cycles, a field in which we offer maximum accuracy, simplicity and durability. Our products are now serving in many and varied applications—in industry, government (including the armed services, particularly in the field of aviation) and for laboratory uses.

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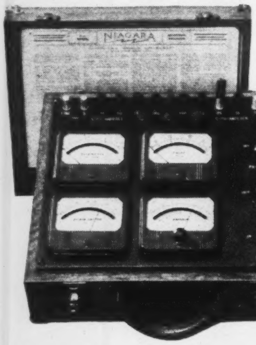
checked in a "go-no go" fashion are gain, threshold, saturation, and signal symmetry.—*Micro Gee Products, Inc., Box 1005, 6100 W. Slauson Ave., Culver City, Calif.*

For more information circle **386** on inquiry card.

A-C POWER ANALYZER

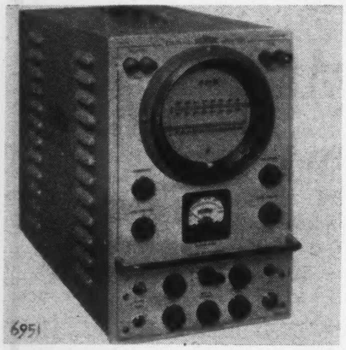
New "Model 77-A-4" is for use in analyzing power loads; indicating volts, amperes, watts and power factor in polyphase and single-phase circuits; all commercial voltages and frequencies. (P.F. indications correct only on 3-phase 3-wire circuits.) Instruments are all electrodynamic class.—*Niagara Electrical Instrument Co., Ellicott St., Buffalo 3, N. Y.*



For more information circle **387** on inquiry card.

AUTO ENGINE TESTER

New "Engine Analyzer" enables a garage mechanic to detect motor ailments accurately in a matter of seconds. Test leads are clipped to ignition system; patterns then appear on screen so that mechanic can tell in seconds the location and nature of troubles.—*Allen B. Du Mont Labs, Inc., 760 Bloomfield Ave., Clifton, N. J.*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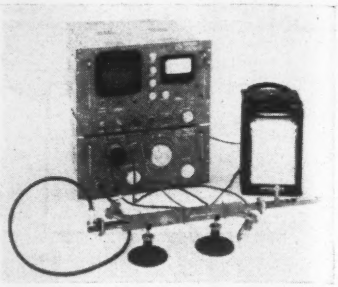
For more information circle **388** on inquiry card.

SWEEP-FREQUENCY VSWR MEASURING SYSTEM

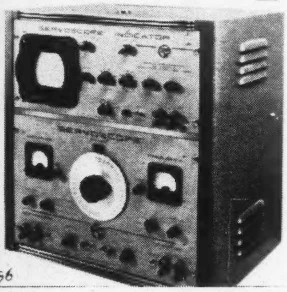


New "Model 125A" enables instantaneous observation and/or recording of VSWR versus frequency, offers the speed and accuracy of a ratiometer system using a bi-directional coupler. Over-all accuracy of system is within 2%. Sweeping at either 1 cps or 0.1 cps, instrument facilitates wide-band tuning operations in lab or on production line.—*Color Television Inc., 953 San Carlos Ave., San Carlos, Calif.*

For more information circle **389** on inquiry card.

SIGNAL GENERATOR

Newly redesigned "Servoscope" test instrument is both a multiple signal generator and phase angle indicator. As a result of a nation-wide survey of engineers and technicians, its dials, switches and information display were human-engineered to reduce fatigue and increase accuracy. Its applications range from automatic flight control design to testing computer response, checking vibration, testing frequency response of electrohydraulic servosystems, simulating rate gyro, training, etc.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*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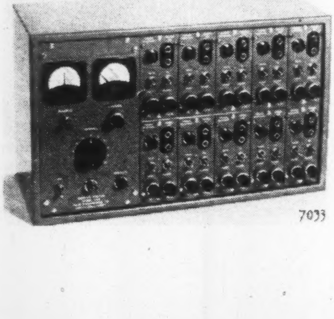
For more information circle **390** on inquiry card.

BRIDGE BALANCE SYSTEM

New "Model C4B Transducer Control System" provides ten channels of excitation and bridge balance controls for oscillographic recording, and accepts three basic types of pickups (magnetic reluctance, strain-gage, and voltage-divider) intermixed,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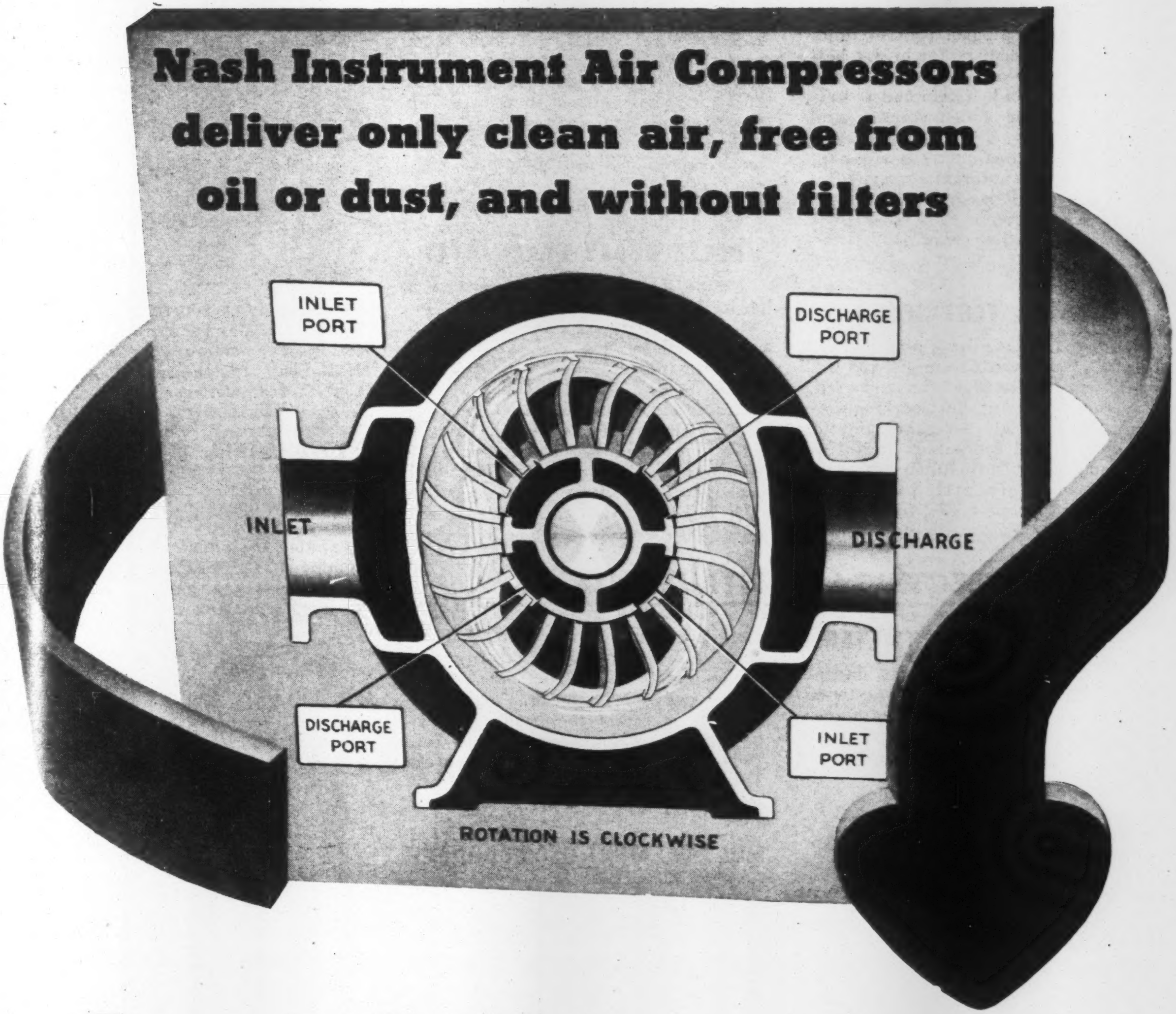
Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

through use of plug-in control units which include circuitry for bridge balance, sensitivity adjustment, and circuit standardizing. (Reluctance unit incorporates also a demodulator and is energized by a 3000-cps carrier supply housed in cabinet.) A stepping switch enables automatic sequential calibration of all recording channels. —*Pace Engineering Co.*, 6914 *Beck Ave., North Hollywood, Calif.*

For more information circle **391** on inquiry card.

CORONA TEST SETS

New self-contained and non-destructive units enable simple and accurate corona testing for research, development or production requirements; include all necessary circuit refinements and controls to permit a continuous and adjustable output. Special sweep circuits provide a straight-line 'scope trace with recurring corona pulses occupying center of trace. Sets meet ASTM, MIL, JAN and IPCEA specs. Economical models are available for use with existing transformers; standard models from small portable units to large sets up to 100 kva capacity and voltages up to 30 kv; special units with voltages up to 80 kv. Safe for operation by unskilled personnel.—*Peschel Electronics Inc.*, 15 *Garden St., New Rochelle, N. Y.*

For more information circle **392** on inquiry card.

PULSE DELAY GENERATOR

New "Model 1000-A" provides a positive pulse variable in delay in increments of 0.1 usec from 1.0 to 999.9 usec. Accuracy of delay is 0.05 usec or 0.01% of indicated delay and is maintained over full PRF range. Other features include a delayed 'scope trigger which enables observing delayed pulse (for all delay settings) on a 10-usec sweep with less than 0.01 usec jitter.—*Obitran Co., P. O. Box* 635, *Lakeside, Calif.*

For more information circle **393** on inquiry card.

ELECTRICAL INSTRUMENTS

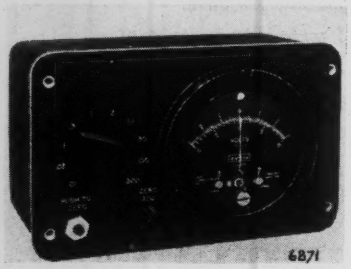
AC-DC DIGITAL VOLTMETER

New "Model 4400" 4-digit digital voltmeter for both ac and dc has twice the accuracy of 3-digit ac-dc instrument announced by maker in 1955. Reading time averages 3 sec for ac and 1 sec for dc readings, and 1" numerals can be read easily from 30 ft. Range 0.001 to 999.9 volts. Range switching is manual on ac and automatic on dc. Stability is 0.01% from 40° to 120°F, with automatic dc calibration; ac calibration set at factory can be adjusted to correct for long-term drifts.—*Electro Instruments, Inc.*, 3794 *Rosecrans St., San Diego* 10, *Calif.*

For more information circle **394** on inquiry card.

MINIATURE VTVM

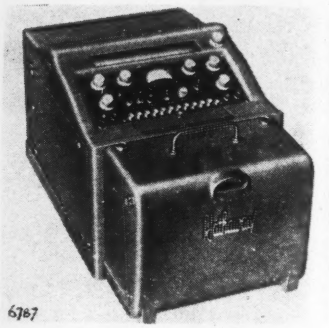
New "Model J" VTVM, small enough to be built into equipment panel, reads from 500 microvolts to 300 volts dc in ten ranges; incorporates a unique chopper amplifier circuit; offers exceptional stability over a wide range of environmental conditions; meets MIL-T-945A and MIL-E-5400; is ready to operate 10 seconds after power is turned on.—*Trio Laboratories, Inc.*, 3293 *Seaford Ave., Wantagh, L. I., N. Y.*



For more information circle **395** on inquiry card.

MULTIELEMENT OSCILLOGRAPH

New "S25" features 12 chart speeds from 1/16 to 160 ips; speed changes possible during operation; timing line intervals from one to 0.001 sec automatically controlled by chart speed or selected manually; galvanometer trace zero adjustment; remote control operation possible from distances up to 100 ft; available w th up to 14 bifilar-type or 36 pencil-t pe coil galvanometers of new desig —*Hathaway Instrument Co.*, 1315 *S. Clarkson St., Denver* 10, *Colo.*



For more information circle **396** on inquiry c rd

22-CHANNEL OSCILLOGRAPH

New "PM-21" 22-channel a to-matic oscillograph is said to h ve "more versatility than ever bef re available to industry" because it ac-commodates 1 to 22 bifilar-type nd four zero-trace galvanometers; nd because one bank of bifilar galva no-

COMBINATION OSCILLOGRAPH AND AUTOMATIC PROCESSOR

New "Model 420 Electrograph" produces up to 24 light-beam-trace records on 8"-wide rectilinear-coordinate charts; features daylight loading, oscillograms readable instantly after recording; timing lines optically impressed from synchronous maste ; traces that can cross one anothe ; trace identification; up to 100 c s without amplification; 7 paper spee . —*Century Electronics & Instrument , Inc.*, 1333 *North Utica, Tulsa, Ok* .

For more information circle **397** on inquiry card.

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GREATEST EASE, SPEED AND PRECISION!

12 TO 20 WEIGHINGS PER MINUTE

TYPE NO.	CAPACITY	PRECISION	TARING RANGE
K-4	4000 g	± 0.3 g	500 g
K-5	2000 g	± 0.2 g	500 g
K-7	800 g	± 0.03 g	100 g

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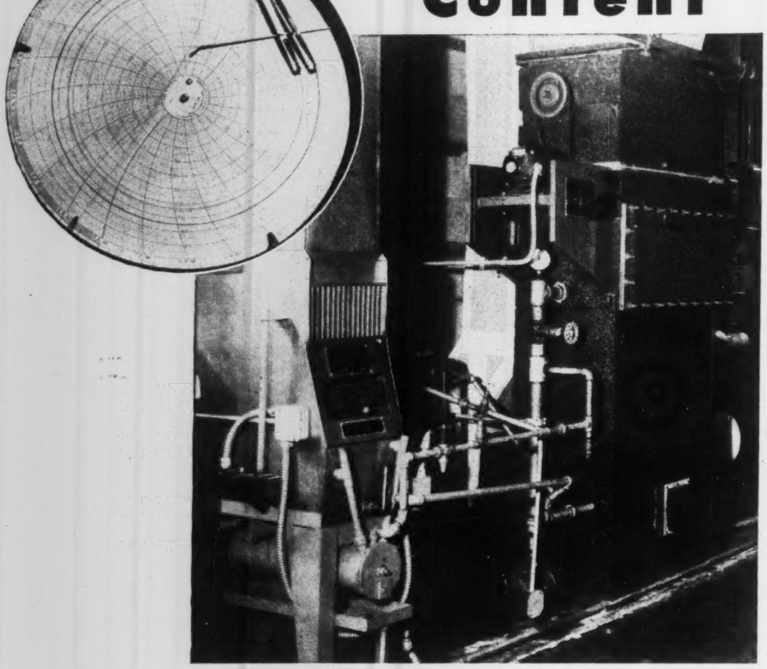

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● This Niagara Air Conditioning Method dries air directly and measurably, using a moisture-absorbing liquid spray. It makes humidity control a separate function from lowering or raising temperatures and gives you precise control with thermostats alone; no moisture-sensitive devices are needed. You have simpler, more trustworthy, less expensive control instrumentation. Niagara precise-control installations have the best record for reliability.

Niagara Air Conditioning provides you with any temperature and relative humidity you need. Using "Hygrol" absorbent, it is not expensive to operate, saving the refrigeration commonly used to condense moisture and making re-heat unnecessary in most cases. It gives large capacity with compact, easily-maintained equipment. Ask for Descriptive Bulletins #112 and #121. Address Dept. – IN.

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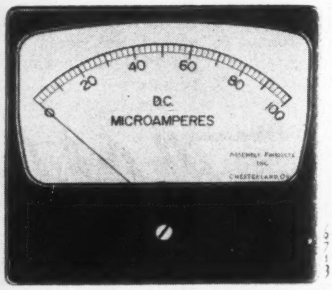
For more information circle **99** on inquiry card.

meters (11) can be replaced with as many as 60 wound-coil galvanometers for recording on-off operations.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **398** on inquiry card.

ELECTRICAL INDICATING INSTRUMENT

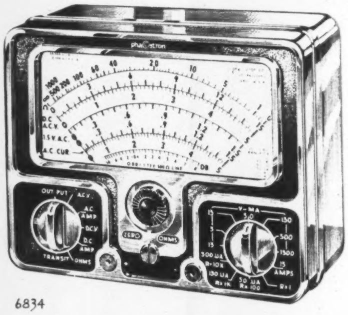
New "Model 461" 4" rectangular black-case panel instrument matches new "Model 461-C Contact Meter-Relay." Special dial plates in many colors or in black and white can be supplied on order for nearly any equipment need. All regular current and voltage ranges can be supplied; also rectifier type ac ranges; also RF ammeters and thermocouple type pyrometers.—*Assembly Products, Inc., Chesterland, Ohio.*



For more information circle **399** on inquiry card.

VOLT-OHM-MILLIAMMETER

New "Model 555A" features movement protection up to 500 times overload; two jacks for all measurements; separate range and function switches (include a transit position); insulated zero adjustment; 43 unduplicated ranges; large color-coded scales. Permanent accuracy 3% dc, 4% ac.—*Phasotron Instrument and Electronic Company, 151 Pasadena Ave., South Pasadena, Calif.*



For more information circle **400** on inquiry card.

AUTOMATIC PHASE INDICATOR

New "Model DAB-101 Automatic Phase Indicator" attaches to conventional slotted line and provides direct readings of relative phase in terms of guide wavelength. Operation is based

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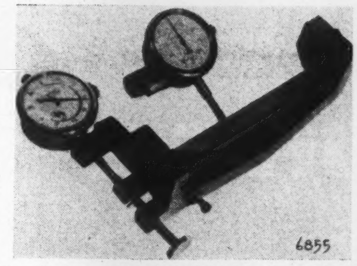
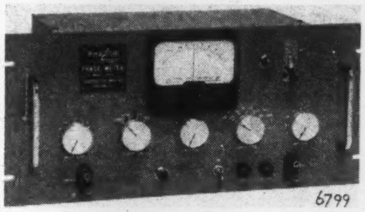


on simple principle of similar triangles, readings of two indicating devices: slope indicator and phase indicator. No calculations are required. Impedance or admittance measurements relative to a fixed point in the line can also be measured.—*Sage Laboratories, Inc., 30 Guinan Street, Waltham, Mass.*

For more information circle **401** on inquiry card.

PHASE METER

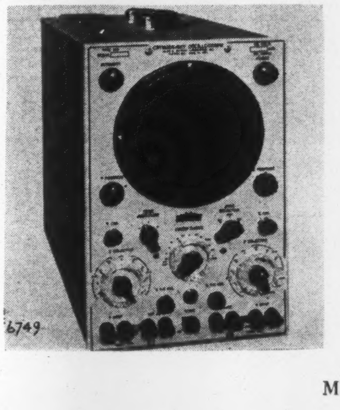
New "Rack Mounted Phazor Phase Meter Model 200A" permits accurate phase shift measurements even though input signals is complicated by noise and harmonic voltages; can also be employed to measure either in-phase or quadrature voltage components. Using special circuit techniques, phase shifts of the order of 0.01° can be measured.—*Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y.*



For more information circle **402** on inquiry card.

GENERAL-PURPOSE CRO

New "Type 350," said to have "an unparalleled combination of features ... the first such instrument in the low-price range offering identical direct-coupled high-gain X- and Y-amplifiers and amplitude calibration on both channels, together with superlative stability." Excellent stability is achieved by an internal self-regulating power transformer. Push-



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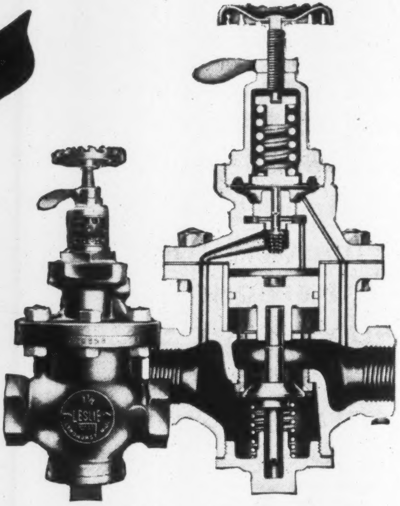

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TYPICAL PRESSURE RANGES

CLASS	BODY MATERIAL	SIZES	INLET STEAM PRESSURES	REDUCED PRESSURE RANGE
LLK	Cast Iron	½"-6"	25-250	2-35
LK	Cast Iron	½"-6"	25-250	10-235
LL-3	Cast Bronze	½"-4"	25-300	2-35
L-3	Cast Bronze	½"-4"	25-300	10-285
LL-4	Cast Bronze	5"-6"	40-300	5-35
L-4	Cast Bronze	5"-6"	40-300	20-275
IS-2	Cast Carbon Steel & Cast Alloy Steels	½"-3"	300-750	100-600
HS-3		1"-3"	300-1500	100-600

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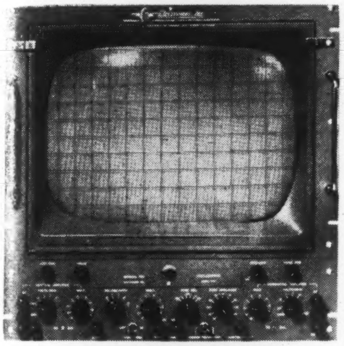
For more information circle **104** on inquiry card.

button amplitude calibration on both X- and Y-channels permits quantitative measurements not previously available in comparable general-purpose instruments.—*Allen B. Du Mont Labs., Inc.,* 750 *Bloomfield Ave., Clifton, N. J.*

For more information circle **403** on inquiry card.

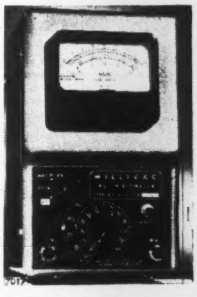
HIGH-SENSITIVITY CROs

New oscilloscopes combine high sensitivity with large screen display: 17" and 21" rectangular tubes, making possible detailed observation of complex wave forms and large quantities of data with minimum interpolation and reading error. Sensitivity is 10 mv peak-to-peak for full-scale deflection. Other features include stable dc amplifiers, calibrated time base and calibrated gain controls.—*Electromec, Inc.,* 5121 *San Fernando Road, Los Angeles* 39, *Calif.*



For more information circle **404** on inquiry card.

TRANSISTOR VOLTMETERS



New "Model MV-45A" transistor voltmeter utilizes principle of "transistor hushing" which minimizes noise. It not only duplicates performance of VTVMs in frequency range (10 cps to 150 kc), voltage range (10 mv to 1 kv) and accuracy (2%) but provides additional more sensitive voltage ranges (lowest 2 to 10 uv). It is operated from a 6-v dry-cell battery with minimum life of 200 hours. ★ "Model MV-45AS" is identical except that it has a hermetically sealed storage battery with built-in charger for over 2,000 hours of operation.—*Millivac Instrument Corp., P. O. Box* 997, *Schenectady, N. Y.*

For more information circle **405** on inquiry card.

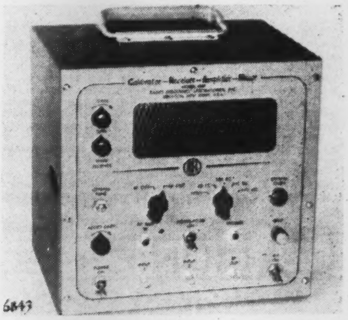
MEGOHMMETER

New "Model L-7" megohmmeter with ranges to 50 million megohms and continuously-variable test voltages of 100 to 600 vdc incorporates features for greater operational ease, accuracy and safety than in previous models; is said to be ideal for testing voltage coefficients of the newer insulating materials. In capacitor testing, it provides charge and discharge facilities to eliminate annoying "meter slam." Unique indicator with logarithmic response is said to make it "the first high-resistance megohmmeter providing uncrowded, easy-to-read, high-end scale."—*Industrial Instruments, Inc., Cedar Grove, N. J.*

For more information circle **406** on inquiry card

CALIBRATOR-RECEIVER-AMPLIFIER-MIXER

New "Model 1051 C-R-A-M" is a new instrument of wide versatility, for use (1) as a secondary frequency



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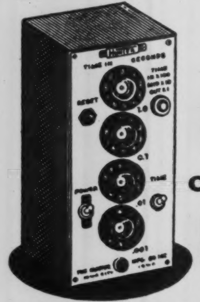
HUNTER

KLOCKOUNTER



1 IN ONE COMPACT UNIT

The Hunter KLOCKOUNTER does the job of a timing clock and a counter. The KLOCKOUNTER will count events at a rate of 2000 per second. Time intervals in units of one-tenth, one-hundredth, or one-thousandth of a second can be measured. The KLOCKOUNTER is completely silent in operation

The Hunter KLOCKOUNTER is an instrument which will meet your most exacting requirements for quality, performance, reliability, and serviceability.

You save when purchasing a KLOCKOUNTER. You have a timer and a decade counter all in one compact unit, weighing less than eight pounds.

Write for more information today. And . . . receive FREE catalog of other Hunter equipment by return mail. It is important to you and you'll always be glad you did.

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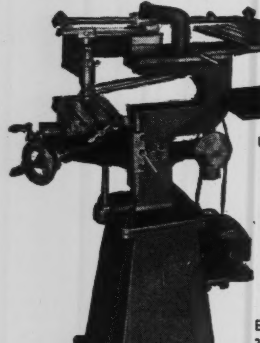
PREIS **Model 2D-4 ENGRAVING MACHINE**

"A medium sized machine that does the work of a larger one"



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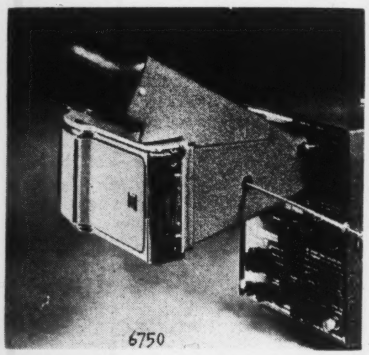
standard of 0.0005% accuracy, (2) for the reception of standard time and frequency broadcasts from WWV, (3) as a moderate-gain audio amplifier for general use, and (4) as a mixer to compare two external signals to each other or to compare one external signal to one of the harmonics or sub-harmonics of its 10-Mc crystal oscillator.—*Radio Frequency Labs., Inc., Boonton* 13, *N. J.*

For more information circle **407** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

OSCILLOSCOPE CAMERA

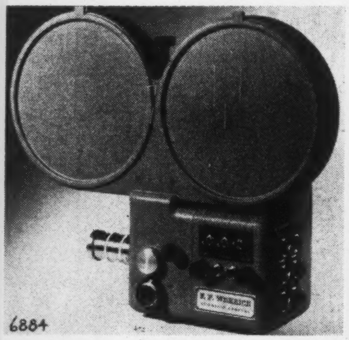
New "Type 339" is said to be the first recorder specifically designed for use with a 3" cathode-ray oscilloscope. It offers full binocular vision, is self-supporting, and produces 2¾ x 3½" prints one minute after exposure.—*Allen B. Du Mont Labs., Inc.,* 750 *Bloomfield Ave., Clifton, N. J.*



For more information circle **408** on inquiry card.

OSCILLOSCOPE RECORDING CAMERA

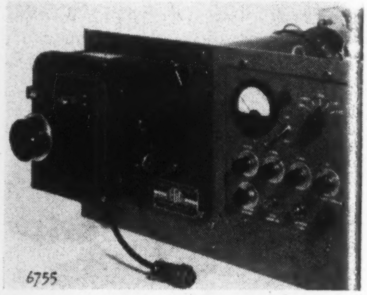
New "Model F7" has a magazine capacity of 1000 ft of 35 mm film; speed range 15 to 125 fps; speed constant within 1.5%. Automatic cut-off switch stops camera after any predetermined footage. Standard features include film plane focusing, overload protection, AN fittings, operational lamps, marker lamps at each edge of film with individual inputs, f 1.5 lens and loop loading magazine. Available extras are thermostatically controlled heaters integral with magazine and a variable-width aperture plate.—*Frederick P. Warrick Co., Clarkston, Mich.*



For more information circle **409** on inquiry card.

TRAVELING WAVE CRT

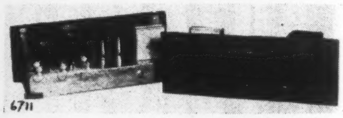
New sealed-off high-sensibility cathode-ray tube makes possible photographic recording of transients in millimicrosecond region. Standard models have a sensibility of 0.02 volt/trace width and a writing speed of 10^{11} trace widths/sec, permitting recording of pulses with rise times of tenths of a millimicrosecond. Remarkably small spot size (0.001") is obtained by optimizing optics of electron gun and focus structure. *Edgerton, Germeshausen & Grier, Inc.,* 160 *Brookline Ave., Boston* 15, *Mass.*



For more information circle **410** on inquiry card.

BROAD-BAND MULTICOUPLER

New "Model AMC-2" Multicoupler feeds, from a single antenna, up to four radio receivers in 215 to 235 Mc frequency band; gives a high degree of isolation between the four outputs: individual receivers can be tuned to different frequencies in this band. New multicoupler, when used with "Model APA-2 Preamplifier," not only allows simultaneous operation but improves signal-to-noise ratio by about 5 db.—*Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.*



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FAST PULSE TRANSMISSION EQUIPMENT

New equipment for wide-band pulse transmission problems from dc to 1 millimicrosecond rise time pulses (0 to 350 Mc): standard co-axial cables in any length with any standard

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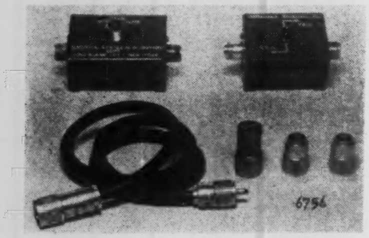
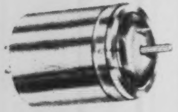


connectors; coaxial line terminations for any impedance from 50 to 200 ohms; pulse splitters-mixers; pulse attenuators, variable pulse delay boxes, etc.—*Electrical and Physical Instrument Corp., 42-19-27th St., Long Island City 1, N. Y.*

For more information circle **412** on inquiry card.

PHASE SHIFTER

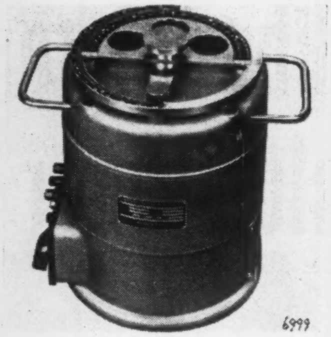


New "Model V 59 Variogon" combines a continuously-variable phase shifting capacitor and driving network, including transformer. This provides in one housing a complete system to give linear phase shift versus shaft angle continuously with 0.5-degree accuracy. Size is 2¼" x 1½" exclusive of shaft and terminals.—*Nilsen Mfg. Co., Addison, Illinois.*

For more information circle **413** on inquiry card.

PHASE SHIFTER

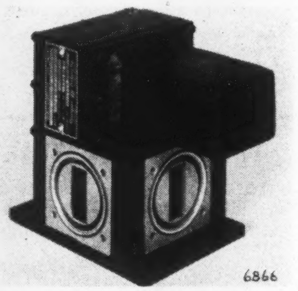
New "Type Q-1" accurately provides any phase shift, from 90° leading to 90° lagging, by manually positioning rotor. Outer scale is calibrated in degrees for electrical angle of displacement; adjacent inner scale, calibrated in corresponding power-factor values, can be temporarily released from rotor and moved independently to permit operator to compensate for any phase displacement between current and potential of test set-up that may have been introduced by other portions of circuit. Thus, true-power-factor can be read directly and accurately under all conditions. —*Knopp Inc., 4250 Holden St., Oakland 8, Calif.*



For more information circle **414** on inquiry card.

WAVEGUIDE SWITCH

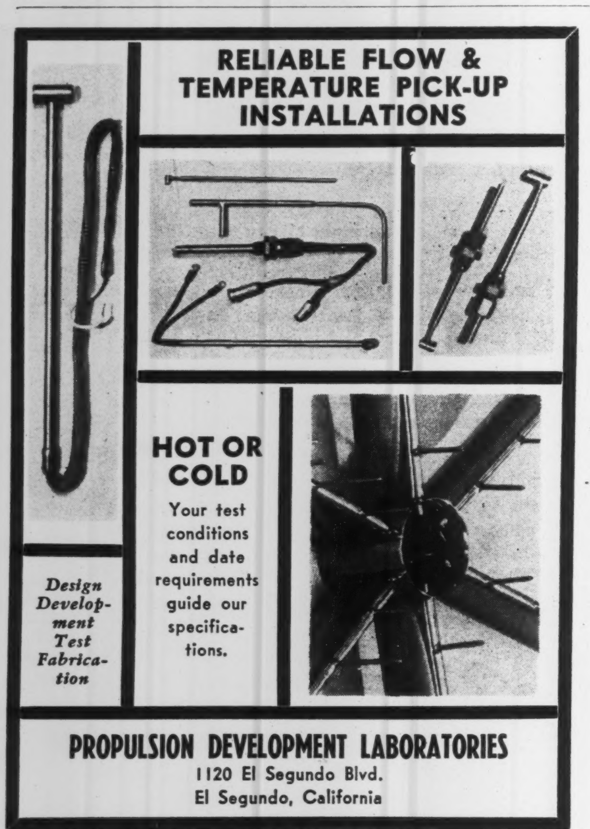
New "Model G14H2AX" airborne waveguide switch, ¾" x 1½" guide size, features: vswr 1.05 maximum in position, 1.15 maximum during switching; crosstalk 45 db minimum; pressurization 45 psig maximum; power handling ability about 0.35 megawatts cw.—*Electronics Div., Dept. N, Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland 3, Ohio.*



For more information circle **415** on inquiry card.

AMPLIFIER-SWEEP ADAPTER

New "Type 2628 Amplifier-Sweep Adapter" for driving maker's "Types 343 and 345" large-screen indicators obviates need of companion oscilloscopes, or "master," for signal source, signal amplification, and sweep generation. New unit enables control of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by Charles H. Single

Presented at the Fall Conference, American Society of Mechanical Engineers, San Francisco Section, San Francisco, October 28, 1955

Data File 123

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Covers the capacity, limitations and practical applications of analog computers to the solution of feedback system design problems.

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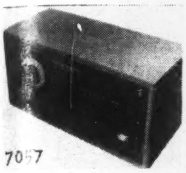
94

For more information circle **109** on inquiry card.

"slave" large-screen indicators through electrical connections up to 200 ft for lectures, demonstrations, and remote monitoring.—*Allen B. Du Mont Labs., Inc.,* 750 *Bloomfield Ave., Clifton, N. J.*

For more information circle **416** on inquiry card.

FREQUENCY STANDARD



New "1232 Spectrum Generator Secondary Frequency Standard" produces a crystal-controlled spectrum of harmonically-related frequencies. Envelope of harmonic amplitudes is uniform from 1 kc to 85 Mc. (Useful harmonics at several thousand megacycles.) Single operating control sets the instrument to any one of six harmonic-interval spacings. A periodic output circuit eliminates usual tuning control: band switching is unnecessary. Self-contained interpolation feature permits fast and accurate measurements of unknown frequencies, receiver drift and transmitter frequency shifts.—*Servo Corp. of America,* 20-20 *Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **417** on inquiry card.

FREQUENCY STANDARD

New "Type 50L" provides frequencies of 40, 50, 60 or 100 cps; accuracies: "50L" 0.02% from −65 to 85°C; "R50L" 0.002% from 15 to 35°C. Tubes used: one 12AT7, one 12AX7. Size: 4½" L, 3¾" W, 5¼" H.—*American Time Products, Inc.,* 580 *Fifth Ave., New York* 36, *N. Y.*

For more information circle **418** on inquiry card.

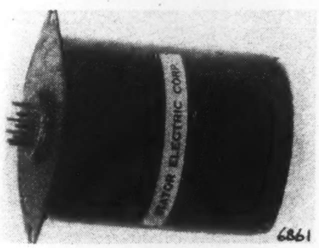
FREQUENCY STANDARD

New "Type 2111C" provides 50 to 1000 cps; has 75-watt output at 110 v (adjustable 0 to 135 v). Accuracy 20 parts per million from 15 to 35°C. Size 17 x 10 x 8¾"; weight 25 lbs. Input 105-125 v 50 to 100 cps. Instantaneous power is adequate in many cases to start motors directly. —*American Time Products, Inc.,* 580 *Fifth Ave., New York* 36, *N. Y.*

For more information circle **419** on inquiry card.

MAGNETIC MODULATOR

New "Model SE-MM-400" high-stability magnetic modulator of second harmonic is said to feature "an un-



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UNITS

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The Lepel line of Induction heating units represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating. With a background of half a century of electrical and metallurgical experience, the name Lepel has become the symbol for quality in induction heating equipment embodying the highest standards of engineering achievement, dependable low cost operation and safety.

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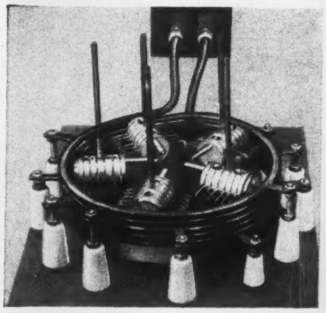

↑ A widely used application in which several assemblies, consisting of a brass body, six radiator fins and a mounting stud, are being soldered simultaneously. The production of similar parts can be further increased by using two work coils and a change-over switch.

The illustration shows a lens grinding block being heated within the dome-shaped work coil. The heat generated in the metal block softens the pitch enabling the operator to remove the ground lenses and insert the next batch. The entire operation is completed in a few seconds. ↓

Electronic Tube Generators—1 KW; 2½KW; 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.
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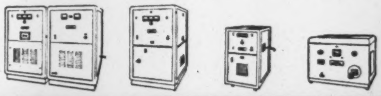

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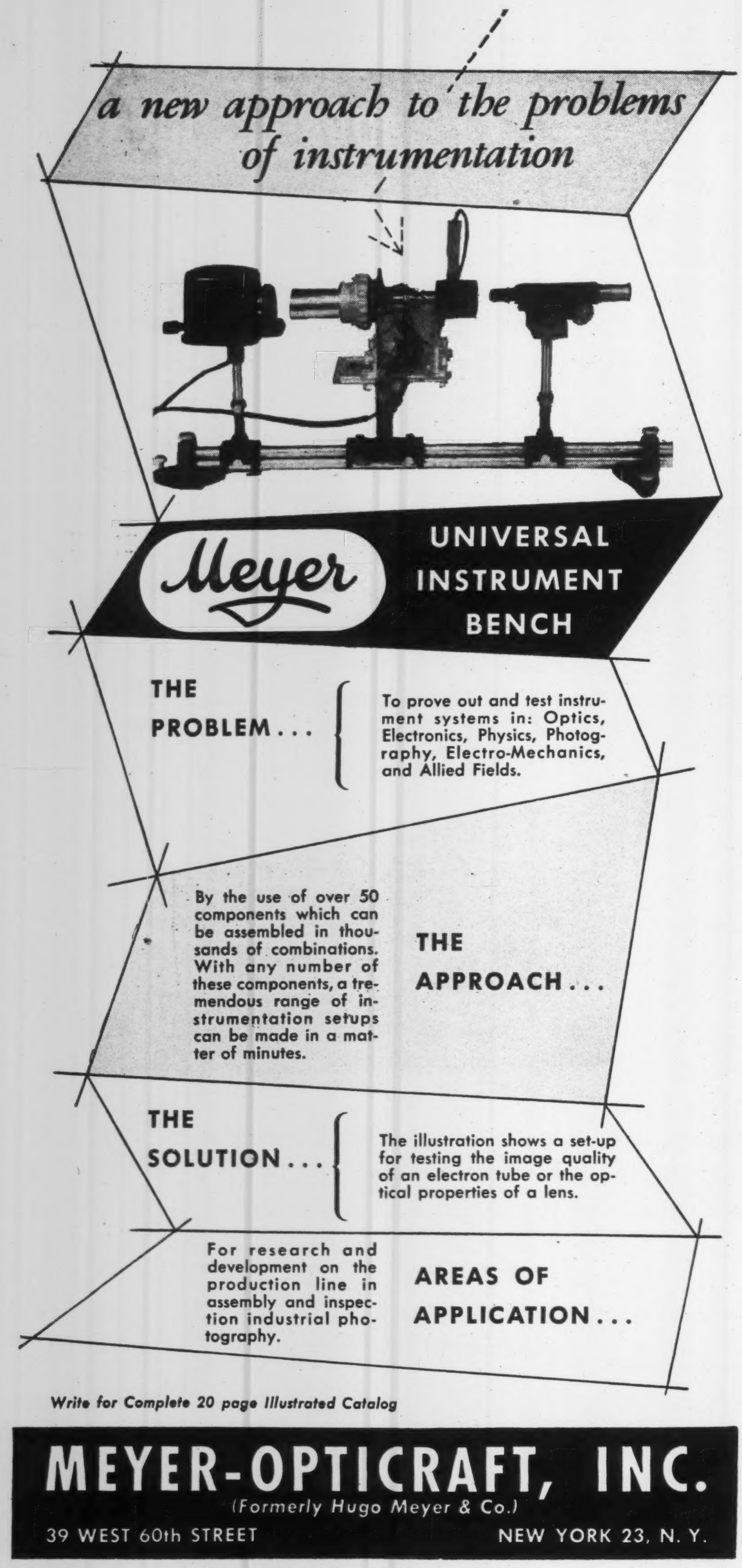

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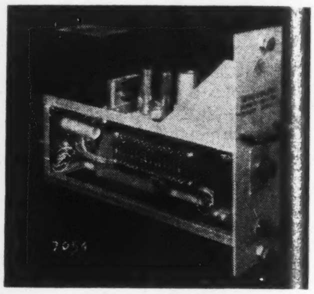
limited life under severest environmental conditions." It is a dc-to-ac converter insensitive to external fields; it does not produce radio interference; therefore is said to be an "ideal miniature converter for sensors like thermocouples in airborne equipment."—*Stator Electric Corp., 46-25 58th St., Woodside 77, N. Y.*

For more information circle **420** on inquiry card.

AMPLIFIERS

AMPLIFIERS

Four new "Servomation Building Blocks" for data transmission, computer, and control systems: "2307

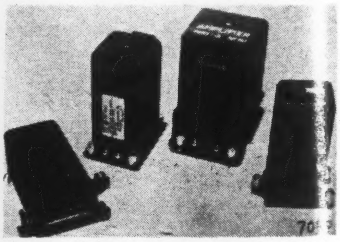


Magnetic Servo Amplifier" is a 400-cps unit with an output capacity of 18 watts, driving any 115-v 400-cps 2-phase servomotor rated at 18 watts per phase. Up to four inputs can be totaled in the input summing network. Any desired ratio of inputs. ★ "2308" is a similar unit, for lighter load of 10 watts per phase. ★ "2309 Vacuum Tube Servo Amplifier" is a 400-cps unit containing beam power output tubes to control any 115-v 400-cps 2-phase servomotor rated at 18 watts per phase. Up to four singled-ended inputs can be summed at input network. Any desired ratio of inputs. ★ "2310" is a similar unit, for lighter load of 10 watts per phase.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **421** on inquiry card.

SERVO AMPLIFIERS

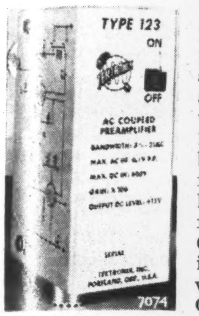
New 400-cps plug-in electronic servo amplifiers, available for immediate delivery, are designed to drive a wide range of instrument motors in aircraft and missile servo systems; are



available in 2-, 4- and 10-watt ranges; are functionally packaged for simple installation; meet USAF specs; will show long life and reliability with high performance characteristics under extreme environmental conditions. —*Servomechanisms, Inc., Eastern Components Div., 625 Main St., Westbury, L. I., N. Y.*

For more information circle **422** on inquiry card.

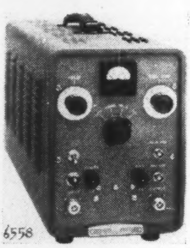
MINIATURE PREAMPLIFIER



New "Type 123" battery-powered low-level ac-coupled preamplifier with a voltage gain of 100, has passband within 3 db from 3 cps to 25 kc, within 2% from 15 cps to 6 kc. Maximum input signal 0.1 v peak-to-peak. Coaxial input and output connectors permit mounting on a CRO or other instrument, or mounting to a cable for use as a probe. Weight 10 oz.—*Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.*

For more information circle **423** on inquiry card.

T-W-T AMPLIFIERS

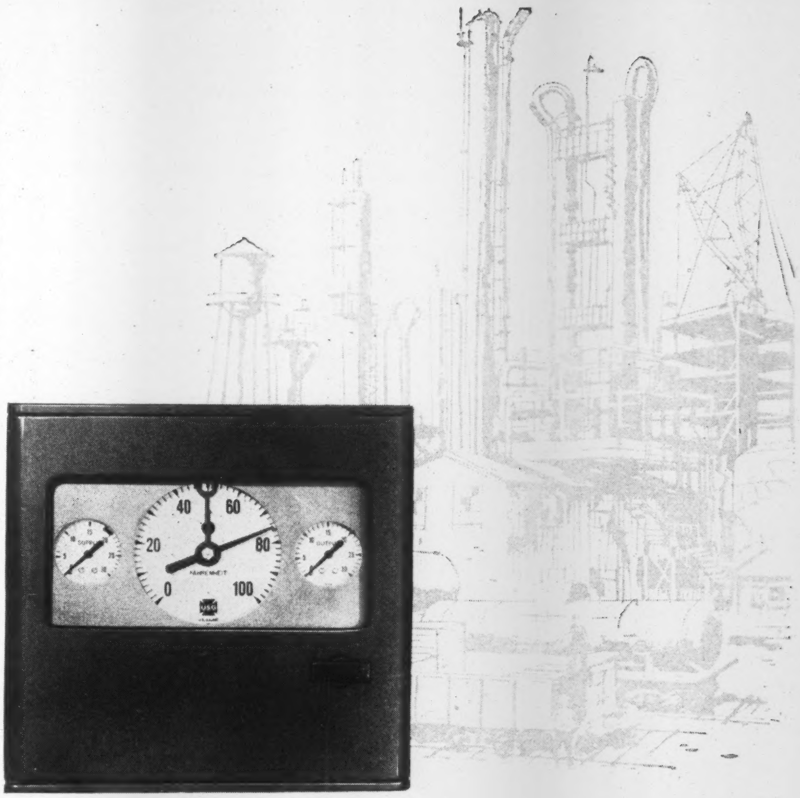


New "Models 492A and 494A Traveling-Wave Tube Amplifiers" give broad band amplification; choice of amplitude, pulse, phase or frequency modulation; constant 25 to 30 db gain; and constant output. They bring convenience of LF measurements to microwave region. "492A" covers 4 to 8 kMc with 30-db gain and 10-mw output; "494A" covers 7 to 12.4 kMc with 25-db gain and 5-mw output. Both have 15 millimicrosecond rise time.—*Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.*

For more information circle **424** on inquiry card.

POST AMPLIFIER

New Post Amplifier, for study of IF amplifiers, is particularly useful for making noise figure measurements in conjunction with maker's Noise Generator. It features an input cathode follower terminating in a 3-db attenuator (utilizing 1% resistors) actuated by a spring-return switch, with provisions for simultaneously controlling noise generator. A panel switch permits selection of two separate amplifiers. An integral VTVM (with a 4" 0-50 microamp movement) serves as an amplitude comparator. Bandwidth: 8 Mc standard; others



PATENTS APPLIED FOR

NEW USG Temperature Pilot

with automatic reset

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The exclusive USG indicating, mercury-actuated temperature pilot is available in ranges from —40°F. to +1000°F.

Pressure and Temperature Pilots are available with or without automatic reset. When process conditions change, conversion kits make possible addition of automatic reset to existing installations.

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For more information circle **112** on inquiry card.

from 2 to 20 Mc to order. Gain: 60 db or greater, adjustable in eleven reproducible steps.—*RS Electronics Corp., 435 Portage Ave., Palo Alto, Calif.*

For more information circle **425** on inquiry card.

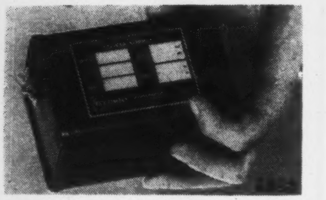
RF PREAMPLIFIER

New "Model APA-2 RF Preamplifier" greatly improves signal-to-noise ratio of a typical radio receiver in 215-235-Mc frequency band, resulting in a better reception of low-strength signals, equal to that which would result (in a typical receiving installation) from a five-fold increase in transmitter power, or an antenna gain increase by a factor of 5.—*Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.*

For more information circle **426** on inquiry card.

POWER SUPPLIES

INSTRUMENT POWER SUPPLY

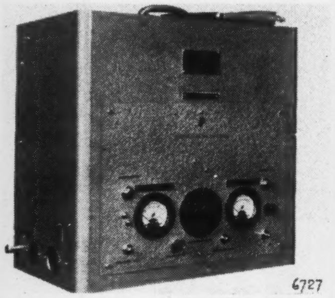


New miniature "Model MP-5-1 DC Voltage Standard" provides stable dc power for bridge-type null-balance circuits, etc.; replaces conventional battery packs; is tubeless, precisely regulated for line and load changes, operates over input range of 35 to 135 vac (360-440 cps) at 10% full load and 70 to 135 vac at full load. Standard output rating is 5 vdc at 1 amp. Units can be placed in series for higher voltages.—*Timely Instruments & Controls Corp., 1645 W. 135th St., Gardena, Calif.*

For more information circle **427** on inquiry card.

H-V D-C POWER SUPPLIES

New "Models 207, 208 and 209" provide up to 30,000 v at 5 ma continuously, 6 ma for 4 hours at maximum voltage and 7 ma continuously below 25,000 v. Standard features include "covat" (*CO*ntinuously *V*ariable *A*uto*T*ransformer); HV "hold", "lock" and "off" pushbutton switches; etc.—*Beta Electric Corp., 303 E. 103 St., New York 29, N. Y.*



6727

For more information circle **428** on inquiry card.

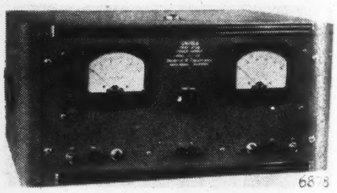
DC-TO-DC POWER SUPPLIES

New completely transistorized dc to dc power supplies weigh about 6 oz; can produce up to 16,000 v from 1½ v of input; can be used in all cathode ray and infrared applications; withstand 20,000 *G* or more, recover instantaneously from shorting, operate at ambient temperatures from −25°C to 100°C.—*Universal Atomics Corp., 19 E. 48th St., New York 17, N. Y.*

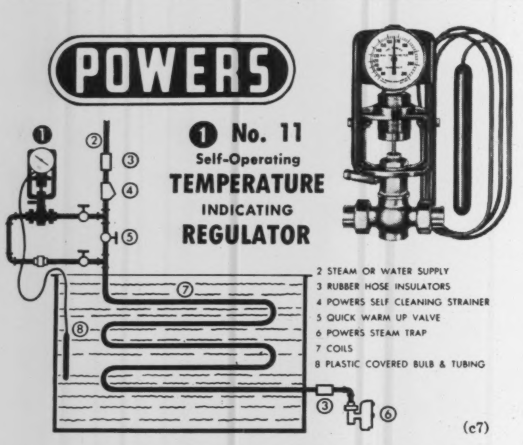
For more information circle **429** on inquiry card.

MAG-AMP-REG SUPPLY

New "Unireg Model U32-10" is a magnetic amplifier controlled dc power supply with a voltage range of 0-32 and current continuously variable from 0 to 10 amp. Regulation for



POWERS



For Electroplating and Other Processes

If you want to hold a liquid in a steam heated or water cooled tank or vat at a uniform temperature use a Powers No. 11 Regulator. It is simple, dependable, easy to install and has a 4" dial thermometer. It indicates temperature of liquid being controlled and makes it easy to adjust regulator for various temperatures. For electroplating, thermal bulb and tubing are plastic coated and highly resistant to corrosion. Standard regulators have copper bulb and capillary tubing.

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THE POWERS REGULATOR CO.
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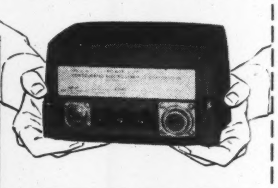
Over 60 Years of Automatic Temperature and Humidity Control

For more information circle **113** on inquiry card.

new compactness for flight-test recording

CEC's Type 3-134
Airborne Oscillograph
Power Supply



Here's the most compact power supply converter ever offered for operating d-c type oscillographs in aircraft equipped with 400-cycle a-c power. Small enough to be located almost anywhere in the plane, operation is unaffected by vibration (contains no moving parts), and the unit may be mounted in any position.

SPECIFICATIONS . . .

Output Power . . . 26 volts d-c, 20 amp. intermittent, 13 amp. continuous

Input . . . 200 volts, 400-cycle, 3-phase

Regulation . . . Output held within 23.5 to 28.5 volts d-c for any combination of line voltage (190-210 volts a-c) and load variation (3-20 amperes)

Ripple factor . . . 0.08 max.

Size . . . 7½" x 5" x 4½"

For complete information, write today for Bulletin CEC-1567-X1.

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ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena, California

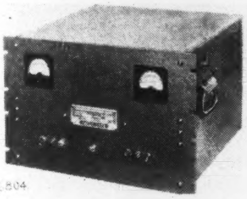
For more information circle **114** on inquiry card.

line or load is 0.5%. Ripple is less than 0.1% for all load and line conditions. Input 105-125 vac at 50-60 cps.—*Universal Electronics Co., 1720-22nd St., Santa Monica, Calif.*

For more information circle **430** on inquiry card.

REGULATED POWER SUPPLIES

Four new groups of voltage-regulated power supplies comprise sixteen models. Each of four voltage ranges



(0-150 v, 195-325 v and 295-450 v) is available at 125 ma, 300 ma, 600 ma and 1.5 amp. All 16 models feature regulation better than 0.2% for line fluctuation from 105 to 125 and no-load to full-load.—*Kepco Laboratories, 131-38 Sanford Ave., Flushing 55, N. Y.*

For more information circle **431** on inquiry card.

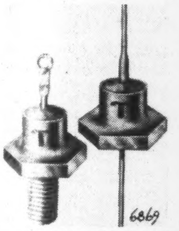
HEAVY-DUTY SUPPLIES

New "H Series" heavy-duty high-current fixed-voltage supplies are obtainable in voltages from 50 v (±25v) to 375v (±25v) in 25-v steps, with current ranges of 0-1, 0-2, and 0-3 amps. Dc outputs are adjustable ±5%. On standard models, regulation is 0.5% and transient response is 1.0 millisecond. On precision models, regulation is 0.1%, ripple 2 mv and transient response 0.1 millisecond.—*Universal Electronics Co., 1720-22nd St., Santa Monica, Calif.*

For more information circle **432** on inquiry card.

RECTIFIERS

SILICON POWER RECTIFIERS



New "Types 1N254, 1N255, and 1N256" have peak inverse voltage ratings up to 600; handle up to 400 ma at 135°C. No-derating temperature range −55°C to 135°C, 500-*G* shock test, and 5000-*G* centrifuge test, insure reliability under the most severe operating conditions.—*Transitron Electronic Corp., Melrose 76, Mass.*

For more information circle **433** on inquiry card.

PRINTED-CIRCUIT RECTIFIER

New miniature selenium rectifier has special terminals which snap into printed board easily but with enough mechanical rigidity to hold rectifier firmly in place, making soldering necessary only for good electrical con-

Kearfott
3" VERTICAL
GYRO

GYROS
designed beyond
requirements

To give the vital few minutes of service required by a missile, gyros must possess ruggedness and dependability that will give them life of a thousand hours or more. Kearfott Gyros possess this ruggedness and dependability. That is why they are so widely used in other forms of aviation as well as in missiles. Kearfott Vertical Gyros conform to MIL-E-5272 A Procedure 11, parts 1 and 2. Kearfott Free Gyros withstand vibration of 5-500 cps at 5 G's, 5 to 2000 cps at 3 G's and 6 G shock of .015 sec duration. Kearfott has Gyros for every application. Write for technical data.

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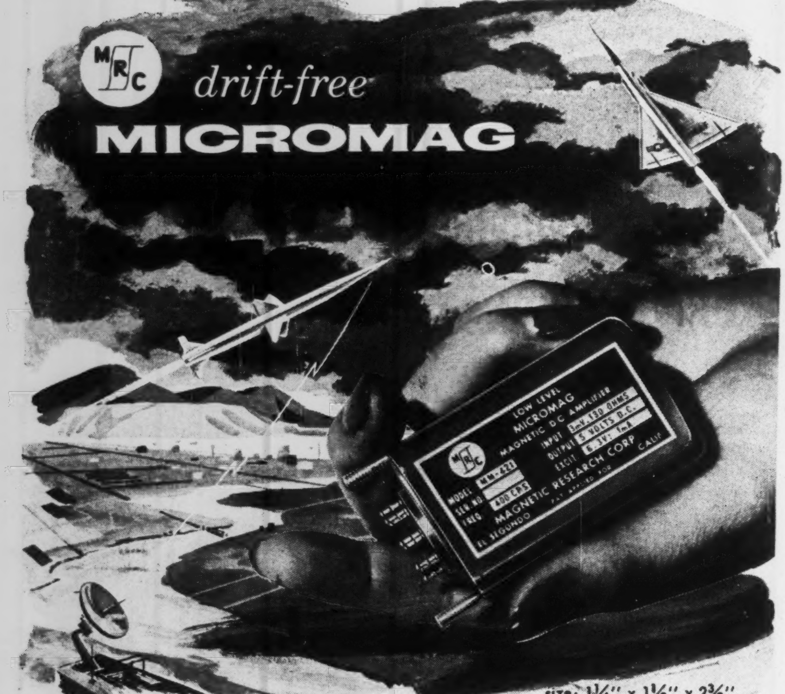


size: 1¼" x 1½" x 2⅜"
weight: less than 7 oz.

LOW-LEVEL MAGNETIC D. C. SIGNAL AMPLIFIER

for thermocouple and strain gage applications in telemetering systems

RUGGED, ALL-MAGNETIC construction assures exceptional stability under the most severe conditions. No moving parts, no fragile elements. Unit withstands extreme vibration and shock without introducing spurious noise, and delivers reliable performance in high environmental temperatures. Produces 5 VDC output from 1 millivolt DC input, with exceedingly high gain stability. Used in all major aircraft and missile instrumentation projects as well as for temperature and strain measurements in industrial and medical applications.

FEATURES

- Gain change of less than 2% for temperature change of 100° C.
- Gain change of less than ½% for line voltage changes from 105 to 125 volts.
- High DC voltage gain, ripple-free. 5 VDC output from 1 millivolt DC input.
- Responds only to DC; signal sensitivity 10^{-12} watts
- No pickup — no lead shielding required.
- All magnetic — maintenance-free.
- Response time 40 milliseconds.
- No tubes — no warm-up time, generates no heat.
- Power requirements less than 10 milliwatts.
- Temperature compensated control circuit.
- Hermetically sealed in thermosetting plastic.
- Magnetically shielded.
- Long life, extremely rugged and reliable.
- Operates from standard 400-cycle supply.

for further information, write for Bulletin EB-201-A

MAGNETIC RESEARCH CORP.
200 CENTER STREET • EL SEGUNDO, CALIFORNIA

Mfrs. of Magnetic Amplifiers and Converters, Magnetically Regulated DC Power Supplies, Magnetic Pulse Generators.

For more information circle **116** on inquiry card.

tact. Available in production quantities are half-wave stack "Types 8Y1B and 8J1B," rated at 30 ma and 65 ma respectively, at off-the-line voltages, with a capacitive load in ambient temperature of 45°C. Both stacks mount in 3/32" holes spaced on 27/64" centers.—*Semi-Conductor Div., Radio Receptor Co., Inc.,* 251 *W.* 19th *St., New York* 11, *N. Y.*

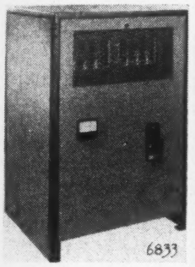
For more information circle **434** on inquiry card.

MINIATURE RECTIFIERS

New subminiature selenium rectifiers, totally encapsulated, meet rigid MIL specs; feature low forward drop combined with low reverse leakage, uniformity of electrical characteristics from stack to stack, and performance at high ambient temperatures. Units have $\frac{3}{16}$", $\frac{5}{16}$" and ½" dia plates. Half-wave type available from 0 to 148 v peak inverse; full-wave types 0 to 74; ratings to 25 ma dc.—*Bradley Labs.,* 169 *Columbus Ave., New Haven* 11, *Conn.*

For more information circle **435** on inquiry card.

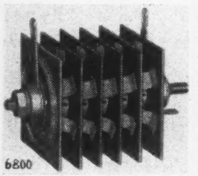
HEAVY DUTY RECTIFIER



New "Model G 125-400" 50-kw heavy-duty germanium type rectifier delivers 115 to 125" v at 400 amp; features compact design and "amazing flexibility in application." Voltage regulation 5% no-load to full-load; efficiency 94%; power factor 95%. Prompt delivery.—*Perkin Engineering Corp.,* 345 *Kansas St., El Segundo, Calif.*

For more information circle **436** on inquiry card.

SELENIUM RECTIFIER

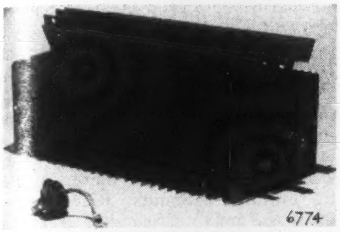


New "Air-Kore" selenium rectifiers utilize a new concept in surface contact while retaining reliable "center support" construction used since inception of selenium rectifiers. This new construction features a unique open-spaced six-contact spring which provides greater contact area and a uniform temperature rise across surface of rectifier plate. Design permits optimal circulation of air around plates, through core and spring; assures Maximal air flow in any vertical mounting position regardless of degree of rotation of rectifier. "Air-Kore" is available in all standard sizes of TV selenium rectifiers.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **437** on inquiry card.

HIGH CURRENT RECTIFIER

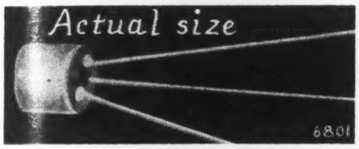
New "ZJ 15" high current silicon rectifier (shown in front of a comparable dry type of rectifier) is capable of operating at 50 amp forward current per cell at 200 v peak inverse voltage with max rated stud temperature of 150°C. Depending on whether it is connected in a single-, 3- or 6-phase circuit, max forward current is rated at 50, 46 or 35 amp. It withstands 500 *G* shock; comes hermetically sealed in metal case with welded seams.—*General Electric Co., Electronics Park, Syracuse, N.Y.*



For more information circle **438** on inquiry card.

SELENIUM RELAY RECTIFIER

New "Type 60-9267" subminiature epoxy-encapsulated selenium relay rectifier to energize dc relay coils is a full-wave center-tap rectifier; can be used either as such or as a half-wave and "back-wave" rectifier combination for compact relay power supply. Rated for 66 v max ac input, it will deliver 22 ma dc as center tap or 11 ma as half-wave. Operating temperature range −50°C to 100°C. Three pigtail leads for easy wiring directly on relay coil.—*International Rectifier Corp., El Segundo, Calif.*

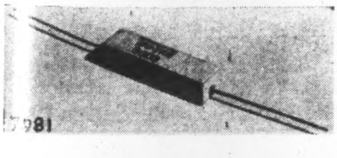


For more information circle **439** on inquiry card.

ELECTRICAL COMPONENTS

MEDIUM-WATTAGE RESISTORS

New "Blue X-60 Series" resistors are wound on a fibre glass core made to rigid specs to insure uniform winding. Wire leads projecting axially from body are mechanically secured and soldered to terminal bands securely clamped to resistance element, which is sealed from moisture by a specially-formulated silicone cement. Ceramic case, colored a distinctive



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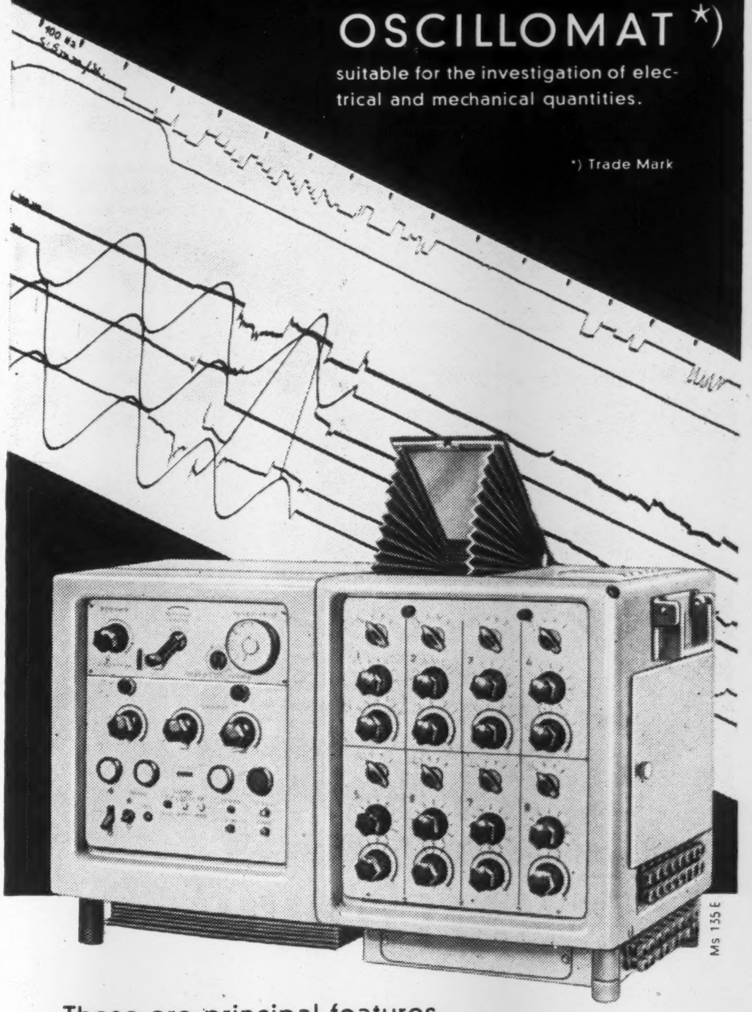

These are principal features . . .

Automatic paper feed · Automatic paper stop · Automatic preparation for the next record · Automatic light-source control · Automatic record numbering · Automatic marking of record end · Remote triggering · Phenomenon-controlled records · Continuously variable paper speed from 0.0033 to 33 ft./sec · Linear frequency response up to 6,000 cps.

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For more information circle **117** on inquiry card.

blue, withstands 1250-v breakdown test even after being exposed to high humidity. Ratings: 5, 7 and 10 watts. —*Tru-Ohm Products, 2800 N. Milwaukee Ave., Chicago, Ill.*

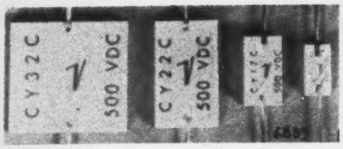
For more information circle **440** on inquiry card.

SOLID TANTALUM CAPACITOR

New "Type STA" departs from conventional design in that it is solid—no liquid or paste electrolyte. Operating temperature range extends from −70°C (−94°F) to 85°C (185°F). Moreover, "STA" operates more satisfactorily at higher frequencies than do conventional electrolytic capacitors. "STA" will be produced in a variety of sizes and ratings.—*Fansteel Metallurgical Corp., North Chicago, Illinois.*

For more information circle **441** on inquiry card.

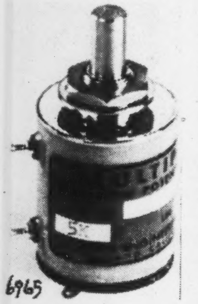
LOW-LOSS CAPACITORS



New low-loss highly-stable capacitors are laminates of porcelain and fine silver; give predictable performance over wide temperature limits (−55 to 200°C). Temperature coefficient is 120 ±5 ppm/°C as defined by MIL-C11272A from −55 to 85°C. Capacity drift as defined by MIL-C-5 and MIL-C-11272A is less than 0.05%, essentially absolute retrace.—*Vitramon, Inc., Dept. ED, Box 544, Bridgeport 1, Conn.*

For more information circle **442** on inquiry card.

HELICAL VARIABLE RESISTOR



New "Series D Multipot" is said to feature "extremely high reliability and ruggedness, the result of a radical new design created for a missile application." Size 1"D x 1.3"L. Resistance range 50 to 125,000 ohms; linearity accuracies to 0.05% are available. Axial drive eliminates brush contact as a driving member. Brush contact of new design keeps noise level low even after millions of revolutions at speeds as high as 450 rpm. Power rating 3 watts at 40°C. Operating temperature range −55° to 100°C.—*Ford Engineering Co., Inc., Upland, Calif.*

For more information circle **443** on inquiry card.

VARIABLE DELAY LINE

New 1-microsecond "Helidel" meets demand for another precise passive delay line having a longer total delay than in 0.2-usec and 0.3-usec units. Delay is adjustable in increments of 0.04 millimicroseconds. Rise time is 0.08 usec max; frequency response 0 to 4.5 Mc; overshoot and phase distortion negligible; mechanical rotation 3600° +5° −0°; diameter 3¾".—*Helipot Corp., 916 Meridian Ave., So. Pasadena, Calif.*

For more information circle **444** on inquiry card.

ELECTRONIC COMPONENTS

VOLTAGE-REGULATING TUBES

New complete line of miniature and subminiature fixed and adjustable corona-discharge voltage-regulator tube is announced. Tubes are especially suited for stabilization of voltages from 300 v to 30 kv at currents below several milliamperes. When required, voltage tolerances can be kept to within 1%. All tubes operate at tempera-

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Save Space and Weight with BRIDGEPORT ¼" diameter bellows

Bridgeport seamless metal bellows of ¼" and 5/16" diameter now permit additional miniaturization in aircraft, instrumentation, and other equipment. At the same time, they provide excellent sensitivity to pressure or temperature changes. Available in many metals with many characteristics. Larger sizes also available.

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For more information circle **119** on inquiry card.

tures from −55°C to 75°C. Total change in regulated voltage for tubes below 4000 v over this temperature range is about 1% of operating voltage; for higher-voltage tubes, considerably less. Maker's "Varijust" design is immediately available in 650-800-v range; can be made available for other voltage ranges in large quantities. —*Anton Electronic Labs., Inc., 1226 Flushing Ave., Brooklyn 37, N. Y.*

For more information circle **445** on inquiry card.

DISC CATHODE

New disc cathode permits TV tube manufacturers to use a narrower glass neck, reducing deflection yoke, ultimately cutting production costs. Its diameter is 0.365", in contrast to standard 0.490".—*Superior Tube Co., 1504 Germantown Ave., Norristown, Pa.*

For more information circle **446** on inquiry card.

FILAMENT TRANSFORMER

New "Type J3-05" liquid filament transformer is of a unique design combining a specially-developed wet process porcelain high-voltage bushing with remainder of assembly, thus controlling and minimizing dielectric stresses; is insulated with non-flammable askarel and sealed. Features: low temperature rise, corona-free, freedom from atmospheric conditions; furnished with or without sockets for directly mounting rectifier tubes.—*Magnatran, Inc., Kearny, N. J.*

For more information circle **447** on inquiry card.

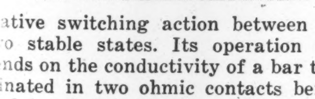
TWIN TRIODE

New "Type 6080WA" twin power triode, designed originally to withstand military application conditions, is now available for commercial use. It plugs directly into any socket using 6080 or 6AS7G series regulator tubes. Max. plate dissipation 13 watts per plate. Shock rating 450 G.—*Chatham Electronics, Livingston, N. J.*

For more information circle **448** on inquiry card.

DOUBLE BASED DIODE

New silicon double based diode (a wholly new semiconductor device) is a microsecond switch having a regenerative switching action between its two stable states. Its operation depends on the conductivity of a bar terminated in two ohmic contacts being modulated by minority carriers injected from a junction located on the bar between these ohmic contacts. This permits it to be operated as



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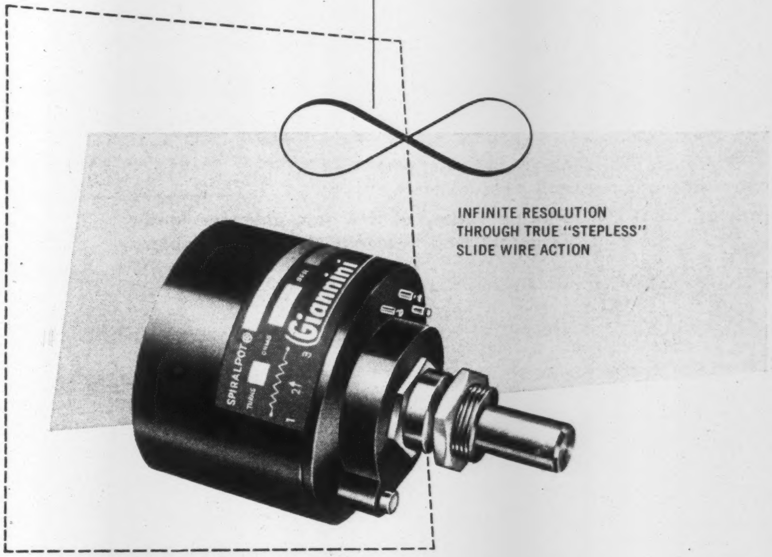
IMMEDIATE DELIVERY

± 0.1% Linearity

10 TURNS
500 OHMS
1000 OHMS
2500 OHMS


INFINITE RESOLUTION THROUGH TRUE "STEPLESS" SLIDE WIRE ACTION
SPIRALPOT
Giannini

Now available for immediate delivery, the Giannini Spiralpot precision potentiometer assures noiseless, accurate performance through true "stepless" slide wire action. The rugged Spiralpot not only mounts identical to conventional wire-wound potentiometers, but has additional advantages in lower weight and smaller behind-panel space. The molded plastic body is only 1.5 inches long by 1.5 inches diameter and the complete unit weighs only two ounces. Low inductance and capacitance effects make it ideal for ac as well as dc applications.

For immediate delivery ten turn Spiralpots having optional resistances of 500, 1000 and 2500 ohms are available as shelf items. *Custom modifications* with respect to resistance, degrees rotation, linearity (±0.1% standard, ±0.05% special), shaft dimensions, rear shaft extension and special rotational tolerances can be supplied upon request.

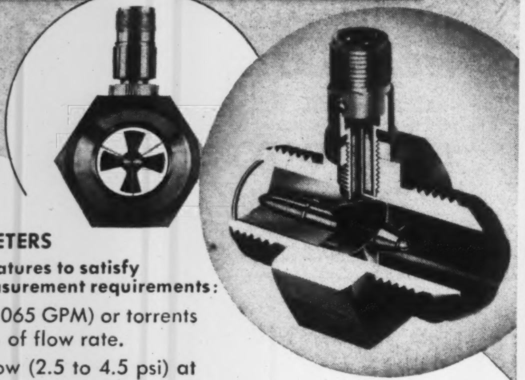
For further information write for Technical Bulletin 85175

Giannini *ELECTROMECHANICAL DIVISION*

G. M. GIANNINI & CO., INC. • PASADENA, CALIFORNIA

For more information circle **120** on inquiry card.

for PRECISE Flow Measurement in TOUGH APPLICATIONS...



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TURBINE FLOW METERS

offer these exclusive features to satisfy your exacting flow measurement requirements:

- Measure trickles (.065 GPM) or torrents (6000 GPM) to ½% of flow rate.
- Pressure drop is low (2.5 to 4.5 psi) at full rated flow in standard models—even lower in others.
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For more information circle **121** on inquiry card.

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Continuous Support and Protection for Instrument Tubing

Tubing may readily be run to individual instruments or panels as needed.

Delicate instruments quickly become useless without adequate tubing support. Instrof provides a flexible, simple-to-install system for maximum efficiency and dependability at minimum cost. Famous Pin-Type Coupling available for wide range of standard fittings and runs.

Instrof is a system of Prefabricated Expanded Metal Trough specifically designed for rigid, continuous support and protection of instrument tubing. All parts are hot-dip galvanized for long life. Widths of 3″, 6″, 9″, 12″, 18″, and 24″, lengths of 8′, 10′, and 12′, and a complete line of fittings allow the Instrof system to meet the demands of virtually any plant layout.

Exclusive Pin-Type Coupling speeds installation and reduces labor costs. Just two coupler pins and a bottom plate are needed to complete a connection.

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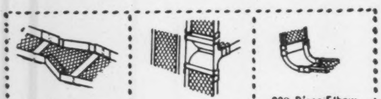


For more information circle **122** on inquiry card.

basic element in astable, monostable, or bistable multivibrators, counters, oscillators, etc. Functionally, it is a 3-terminal negative resistance device capable of 100 mw dissipation at 85°C and a maximum storage temperature of 200°C; Operating temperature range −65°C to 160°C; rise and fall time 1.5 usec.—*General Electric Co., Electronics Park, Syracuse,* N. Y.

For more information circle **449** on inquiry card.

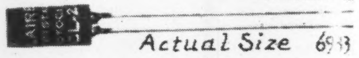
ELECTRONIC TUBES

Fourteen new electronic tubes, developed primarily for new applications within industry, include a high-vacuum rectifier, two new types of high-vacuum amplifiers, seven types of industrial thyratrons, and four new types of ignitrons for welding. —*Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.*

For more information circle **450** on inquiry card.

CRYSTAL PHOTOCELLS

New "Type CL-2" cadmium sulphide photocell (illustrated) replaces "CL-1" and has considerably superior performance characteristics, among them (1) voltage linearity, hence improved performance when applied voltage is alternating; (2) substantially noise-free; (3) better stability; (4) better temperature characteristic. ★ New "Type CL-3" is a cadmium selenide photocell, same size and appearance as "CL-2" but differing in response time, temperature characteristic, and in being most sensitive in red portion of spectrum: advantageously usable with incandescent lamps, flames, auto tail-lights, etc.—*Clairex Corp., 50 W. 26th St., New York* 10, *N. Y.*

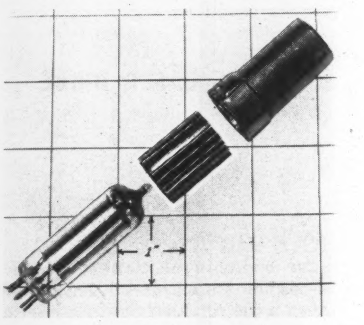


Actual Size 698

For more information circle **451** on inquiry card.

JAN SHIELD INSERT

New insert for standard type JAN shields reduces tube failures, lowers bulb temperatures of miniature tubes by as much as 100°C, provides almost perfect electrostatic shielding.—*Atlas E-E Corp., Bedford Airport, Bedford, Mass.*

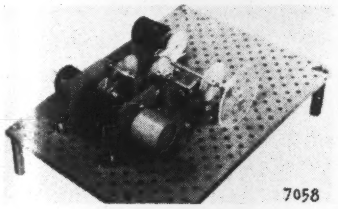


For more information circle **452** on inquiry card.

ELECTROMECHANICAL COMPONENTS

ELECTROMECHANICAL KITS

Newly revamped "Servoboard" electromechanical precision assembly kits have new components; holes in



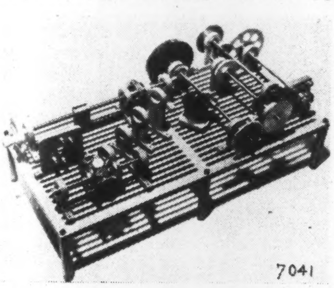
7058

mounting board are now tapped; hanger mounting clamp is a one-piece unit with a captive screw. Result "from-the-top" fumble-free assembly. "Basic Kit Model 1111" meets needs of simple arrays, occasional use and university lab budgets. "Standard Kit Model 1112" will satisfy general requirements. "Master Kit" is ideal for situations where many projects are under way.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **453** on inquiry card.

BREADBOARD PARTS

"Type BB Breadboard Development Parts" are immediately available from stock; permit any desired type



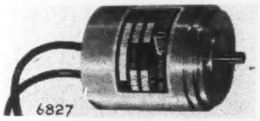
7041

of breadboard model to be quickly and accurately assembled by use of maker's parts. Two basic sizes: 8"x8" and 8"x16"; larger sizes special.—*PIC Design Corp., 160 Atlantic Ave., Lynbrook, L.I., N.Y.*

For more information circle **454** on inquiry card.

SYNCHRO TRANSMITTER

New "Type 3H-3309" 26-v 400-cps synchro transmitter features unprecedented power for its size (2.125"



6827

long, size 18 frame, weight 8½ oz). It can run up to twelve size 15 "Type 2C 005" synchro control transformers. Output voltage on each of the 12 control transformers of this load is 19 v and full-load input current of

HEISE GAUGES

Conquest of the Sky

Heise gauges used by research engineers in the development of modern turbo-jet engines provide the reliability, correlation and repeatability necessary to scientific progress.

Actual operating conditions are reproduced in the Cox Test Stand built by Commercial Research Laboratories to test for optimum efficiency of jet fuel nozzles.

The six Heise gauges incorporated in the test stand feature in the vital and exacting performance which this instrument must accomplish.

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Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

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DELIVERY WITHIN 30 DAYS.

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PYRO — FOR PRECISION TEMPERATURE MEASUREMENTS

NEW! PYRO Micro-Optical Pyrometer

The most versatile optical pyrometer ever designed—unsurpassed in accuracy and ease of operation. Adjusts to focal lengths of 5 inches to infinity and has table-top and floor style mountings with vernier adjustments for telescope sighting. Readily measures targets .001" in diameter. Temperature scales 700-3200°C (1300-5800°F). Write for free Catalog No. 95

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a 12-unit system is 1.42 amp. When used with fewer than 12, less current input to transmitter and increased output voltage on each control transformer; for example, using one control transformer, 0.86 amp input current and 21.8 output voltage. Operating temperature range −55°C to 95°C. Friction @ 25°C is 15 gram-cm and @ −55°C 45 gram-cm.—*John Oster Mfg. Co., Avionic Div., Racine, Wis.*

For more information circle **455** on inquiry card.

CONTACT SWITCH KIT

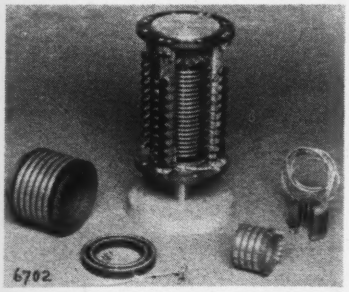
New Contact Switch Kit, for experimental engineers and those who plan, build, repair or test electrically-operated controls, is said to provide all components necessary for assembly of a limitless variety of contact switch combinations. Kit includes assortments of contact blades, insulators, separators, tension plates, angle brackets, side lugs, nylon lifters, contact rivets, washers, screws and bushings.—*Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.*

6785

For more information circle **456** on inquiry card.

SLIP RING ASSEMBLIES

New slip ring assemblies employ precious metal rings and epoxy resin bases; are 100% electrically tested up to 2000 v. Noise level limitations can be held to microvolts and concentricities to 0.001" TIR. Assemblies range from 0.060" to 12" OD and are available with up to 75 circuits, in either pancake or drum types. ★ In addition to slip ring assemblies, makers offer slip rings molded in nylon, Kel-F and Plaskon glass-reinforced resins; also a complete line of compatible brush assemblies using spring-temper precious-metal alloys in round and knife-edge shapes.—*Airflyte Electronics Co., 535 Avenue A, Bayonne, N. J.*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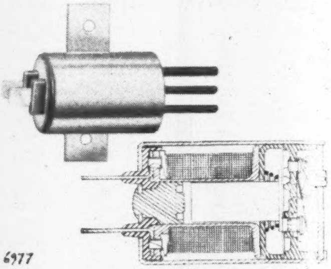
For more information circle **457** on inquiry card.

ELECTROMAGNETIC CONTROL

New "Reloid" is a totally-enclosed plunger-actuated switching device that combines the functions of a relay and a solenoid. Three contact leads are equipped with AMP or Douglas type terminals; coil has two AMP terminals. Units are available for any voltage from 6 to 115, ac or dc. Contacts are rated up to 8 amp at 115 v non-inductive. Length 2-11/32".—*Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.*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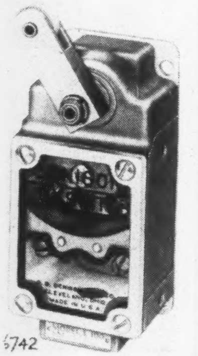
For more information circle **458** on inquiry card.

WATERTIGHT LIMIT SWITCHES

New "Loxswitch" watertight plastic-cover limit switches, said to be the first, permit operator to observe contact action in interior of switch without removing cover. (Previous plastic cover switches were "not watertight and suitable for dusty, oily, wet conditions.") New switches have successfully completed severe kerosene and under-water tests and have received automotive approval. Seven models and 19 contact arrangements available.—*R. B. Denison Mfg. Co., 102 St. Clair Avenue, N.W., Cleveland 13, Ohio.*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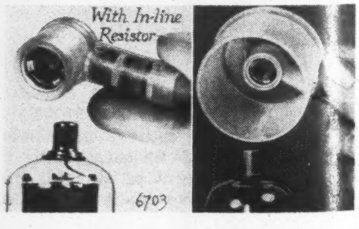
For more information circle **459** on inquiry card.

TUBE CAPS

Two new tube cap designs: (1) for high voltage arc-over and corona suppression; (2) for suppression of corona and voltage insulation at high altitude and high temperatures. Both use maker's new production technique whereby contact, lead, and corona shield assembly is molded as an in-

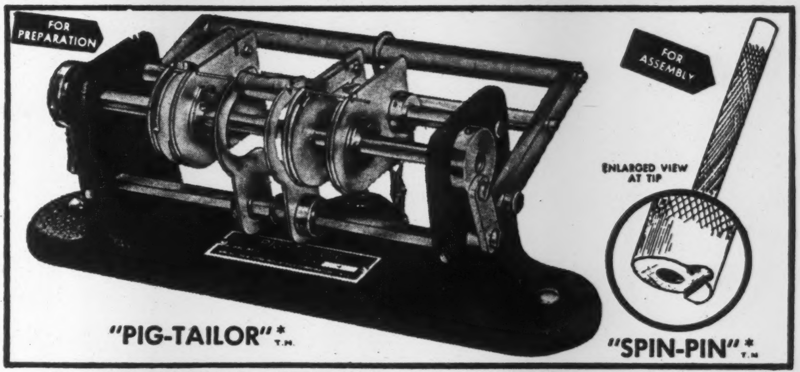


6703

"PIG-TAILORING"

. . . . *a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.*

● ● ● ● ●



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

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By T. H. REDDING

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SCHAEVITZ RVDT'S are widely used in the continuous measurement and remote indication of angular position.

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At National Radiac, Newark, N. J., Thermo Electric equipment is assisting in one of modern science's strangest operations. For here they actually "grow" crystals for scintillation counters—crystals that measure radiation by converting its ionization energy to visible light. The larger the crystal—the greater its sensitivity—and National Radiac grows crystals so large and sensitive they can measure radioactivity from an airplane!

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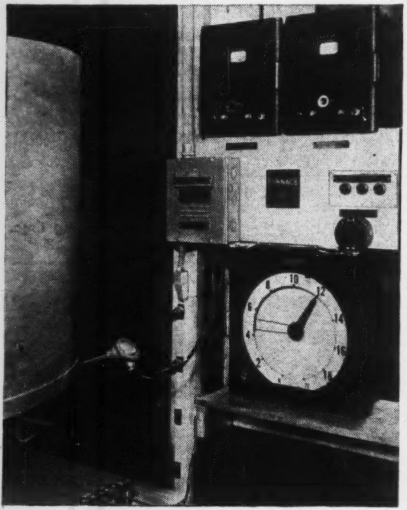
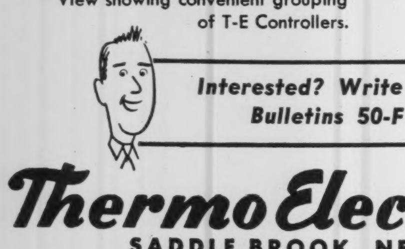


Controllers for furnace 15 with T-E Portable Recorder.

Handling this tough assignment are two types of Thermo Electronic control systems: hi-temperature Resistance Bulbs with Resistance Thermometer Signaling Controllers, and Chromel-Alumel Thermocouples with Potentiometer Pyrometer Signaling Controllers. The success of the system has been outstanding—and its unfailing accuracy continues to aid National Radiac in growing the largest and finest scintillation crystals in the world.



View showing convenient grouping of T-E Controllers.

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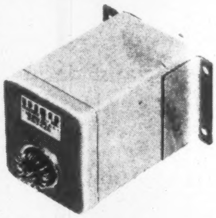
For more information circle 128 on inquiry card.

tegral insert into insulating body, completely bonding wire and connector insulation into one completely sealed unit.—*Alden Products Co., #NPR-36, North Main St., Brockton, Mass.*

For more information circle **460** on inquiry card.

TELEPHONE-TYPE RELAY

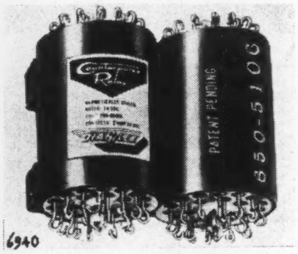


New hermetically-sealed short-form telephone-type relay is said to offer all advantages of long-form telephone relay armature, hinge and contact arms. It can be equipped with many special features including copper slugs for time delay, special contact materials and high-voltage insulation.—*Kurman Electric Co., Inc., 35-18 37th St., Long Island City, N. Y.*

For more information circle **461** on inquiry card.

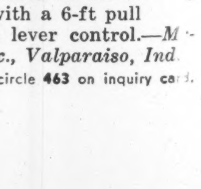
COUNTERPOISE RELAYS

Several new models of maker's counterpoise relay include a tandem-type 24-pole double-throw model illustrated), a 12-pole design, a relay for 400-cps input, and several special application designs, all employing counterpoise principle said to offer "a new relay concept in precision with dependable performance, immunity to vibration and shock, small size and light weight."—*Cook Electric Co., Diaphlex Div., 2700 Southport Ave., Chicago, Ill.*



For more information circle **462** on inquiry card.

SMALL 20-AMP SWITCH

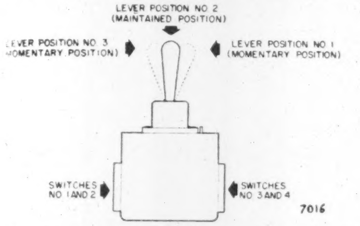


New "Model 2020," said to be "smallest switch made in its capacity rating," has been designed expressly to control up to 2,500 watts safely on heaters, motors, etc.; has a single-pole multiple-break mechanism; can be used on ac or dc; is available with a 6-ft pull chain or a plain lever control.—*McGill Mfg. Co., Inc., Valparaiso, Ind.*

For more information circle **463** on inquiry card.

TOGGLE SWITCH

New "21AT1" toggle switch with an "electrical memory" uses three sp-dt functional basic switches and


LEVER POSITION NO 2 (MAINTAINED POSITION)
LEVER POSITION NO 3 (MOMENTARY POSITION)
LEVER POSITION NO 1 (MOMENTARY POSITION)
SWITCHES NO 1 AND 2
SWITCHES NO 3 AND 4

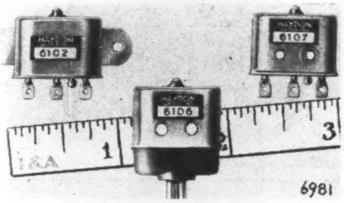
7016

one sp-dt "memory" switch. Latter indicates, through a pilot light or buzzer, which circuit was last actuated. Lever returning to center position does not affect memory switch, which indicates extreme position in which lever is in or was in most recently.—*Micro Switch Div., Minneapolis-Honeywell, Freeport, Ill.*

For more information circle **464** on inquiry card.

SUBMINIATURE SWITCHES

New "6100 Series" subminiature snap switches, said to be "the smallest dry-gas-filled hermetically-sealed



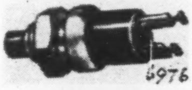
6981

sp-dt units on the market today," are rated 5 amp resistive, 3 amp inductive, 2 amp motor load, either 28 vdc or 110 vac. Electrical and mechanical life 100,000 cycles. Qualified to MIL-S-6743 and vibration MIL-E-5272 procedure I. Available with either bracket or through hole mounting plus potted lead wires good for 250°F. —*Haydon Switch, Inc., 536 Leonard St., Waterbury 20, Conn.*

For more information circle **465** on inquiry card.

PUSH BUTTON SWITCHES

New "Series 30-1" subminiature push button switches, ⅜" dia, extend behind panel 0.592". Nine



6976

switches can be mounted in a 1⅛" square. Rated at 115 vac and 100 ma resistive load; life expectancy over 300,000 operations. Available immediately in a normally-open momentary-contact version—*Grayhill, 561 Hillgrove Ave., LaGrange, Ill.*

For more information circle **466** on inquiry card.

SNAP-ACTION SWITCH

New "TyniSwitch," said to be smaller than any other snap-action switch of equal rating, is 1⅝ x 9/32

whatever is vibrating . . .

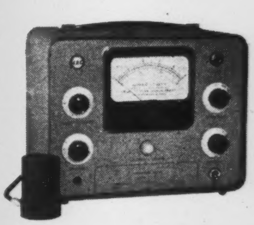
wherever it's vibrating . . .

measure it with CEC vibration meters

Now, CEC offers vibration meters for every purpose, every budget, every condition of use. All use the same CEC self-generating pickups—standard throughout the world—for precision sensing of vibration. Compact, portable *systems*, the companion meters and pickups are equally valuable as laboratory instruments, production-line gages, trouble-shooting aids, and continuous vibration monitors. All models are outstanding in their ruggedness, compactness, and simplicity of operation.

TYPE 1-128 . . . the battery-powered meter you can carry with you, use anywhere to measure the amplitude of vibrations from 10 to 1,000 cps. An *all-transistor, etched-circuit* design, it is unusually accurate and trouble-free. Peak-to-peak displacements appear directly in mils on large, easily read dial. Full-scale indication provided by 0.0005" peak-to-peak displacement. Weighs only 7½ lbs. Send for Bulletin CEC 1566-X17.

TYPE 1-117 . . . for more complex vibration studies (where 115-volt power is available). Provides *direct* readings of both average velocity and either linear or torsional peak-to-peak displacement. Features four input channels with individually adjustable sensitivity . . . interchangeable high-pass filters for low-frequency cut-off . . . highly stable amplifier . . . design adaptable to rack mounting. Send for Bulletin CEC 1538A-X14.



TYPE 1-110B . . . Standard for years at many airbases and engine plants, still offered for replacement or expansion where instrumentation has long been based on their use. Similar in operation to Type 1-117. Send for Bulletin CEC 1505C-X8.

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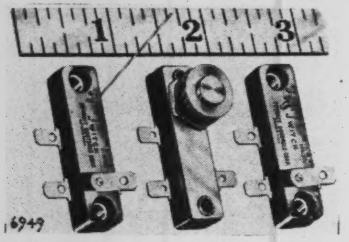
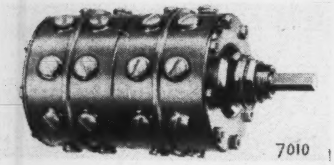


x $\frac{7}{16}$". Only one moving part. Unique blade design produces a fast snap operation with positive maintenance of contact, which is virtually bounceless. Four basic designs, operating force from 3 to 12 oz in pin-operated models, and from 1½ to 12 grams in the wire-operated models.—*Tyni-Switch Dep't, Detroit Controls Corp., 800 Union Ave., Bridgeport, Conn.*

For more information circle **467** on inquiry card.

EXTRA-HEAVY-DUTY ROTARY SWITCH

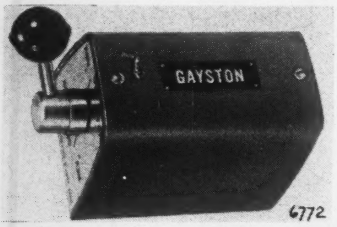
New 2- to 8-position rotary switch, for selecting main power feeders, utilizes a new operating principle: a spring-loaded spring-actuated roller contact seats in a stationary contact groove; additional spring pressure and mechanical linkage force roller from contact groove with high acceleration, causing a quick break and driving roller at high speed to next contact, whence minimal arc. And since arc occurs away from static position, switch life and capacity are maximized. Continuous duty rating 60 amp max.—*Mason Electric Corp., 3839 Verdugo Rd., Los Angeles, Calif.*



For more information circle **468** on inquiry card.

DRUM REVERSING SWITCH

New 1½-hp "Model HC" is said to have many unique construction features to assure durability and superior performance, among them silver-tipped contacts, berylium-copper preloaded contact springs, molded contact block and barrier, self-cleaning butt-wipe contact action.—*Gayston Corp., 1225 Ray St., Dayton, Ohio.*

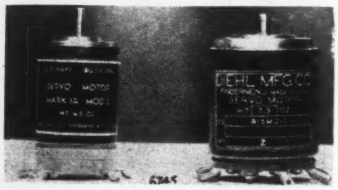


For more information circle **469** on inquiry card.

MOTORS, etc.

INDUCTION SERVOMOTORS

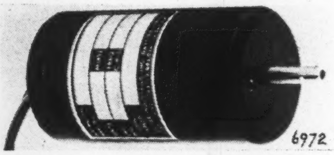
Two new 400-cps miniature induction servomotors (sizes 11 and 15) for industrial applications withstand environmental tests of Armed Services; have high torque-to-inertia ratios. Control phases can be wound for 115 v series connection or 57½ v in parallel, 230 v series, and 115 v parallel.—*Diehl Mfg. Co., Finderne Plant, Somerville, N. J.*



For more information circle **470** on inquiry card

60-CPS SERVOMOTOR

New 60-cps servomotor is available in several models for instrumentation, control and servo-system appli-



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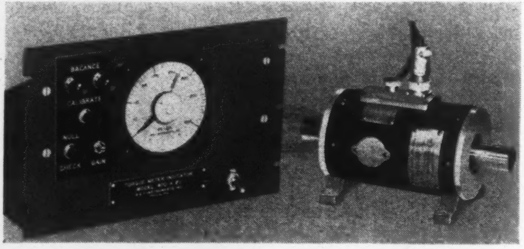
For more information circle **130** on inquiry card.

B&F instruments, Inc.

TORQUE METERS

Torquometers & Indicating Systems for steady state or dynamic measurement of Torque in rotating systems.

Standard and Custom Systems available with details of shaft ends and housing designed to meet customer specifications.



Torquometer generates signals of 100 MV or More with angular deflections of less than 0.75 degrees.

Low Noise slip ring and brush assembly with remote brush lifting mechanism permits high speed measurements to be taken with high signal to noise ratio and long life.

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Other Products:
Accelerometers, Bridge-Balance & Calibrating Units.

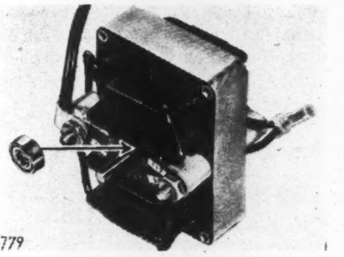
For more information circle **131** on inquiry card.

cations; is 1¼" dia by 2¼" long. Both 2- and 4-pole machines are available with either hysteresis or induction type rotors; also with maker's standard gear reducers or special reducers.—*Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.*

For more information circle **471** on inquiry card.

FHP MOTOR

New "Series 500" induction motor for critical jobs under extreme conditions has ball bearings instead of usual porous bronze sleeve bearing. Operating temperature range is −40°F to 130°F. Available in wide variety of torques; final shaft speeds from 300 rpm to 1 rev per week; can be stalled indefinitely without damage to wiring or overheating.—*Gleason-Avery, Inc., Auburn, N. Y.*

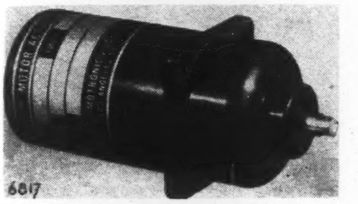


6779

For more information circle **472** on inquiry card.

BRAKE MOTOR

New "Model 206-1005" subminiature motor, with brake, is available with gear reduction ratios from 11.6 to 10,000 to 1. Over-all length 2"; torque output 3 pound-inches with output speed of 20 rpm. Brake stops output shaft in less than 2°; stopping time about 0.008 sec.—*Motronics Corp., 241 Concord St., Glendale, Calif.*

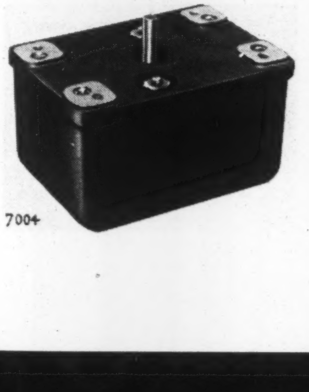


6817

For more information circle **473** on inquiry card.

AC ROTARY SOLENOIDS

New small-torque "400 Series" 60-cps rotary solenoids (added to large-torque "800 Series") operate on standard voltage with low power consumption. Continuous and intermittent



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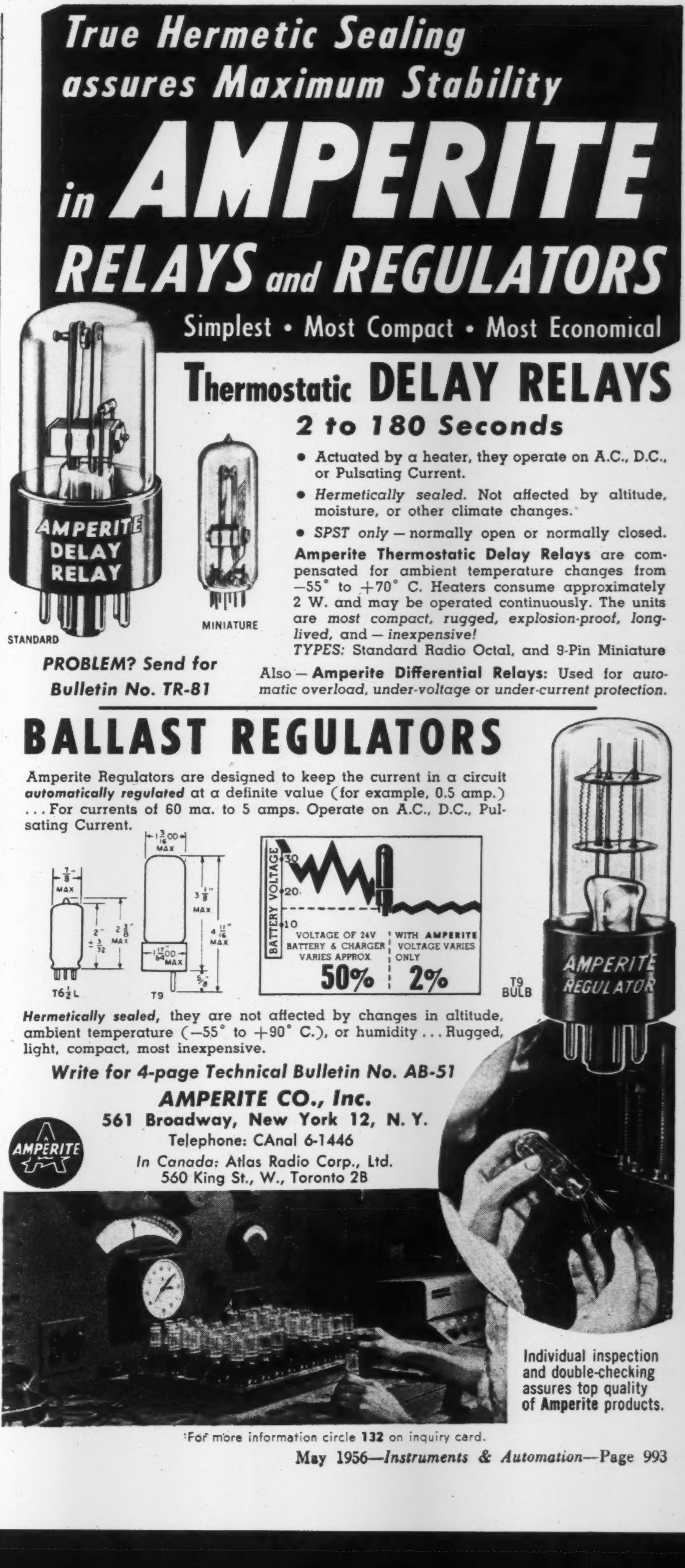

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2 to 180 Seconds

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- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
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Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from −55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

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Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.

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Now a brand new ultra-high-speed reversible data converter . . . DATRAC . . . automatically translates voltages to digital data or reverses the process.
Bulletin just released shows suggested DATRAC applications such as: engine test data translation; reduction of shaft rotation and thermocouple or strain gage information to digital form; precision analog recording and playback; machine tool and chemical process control; and many others. Also includes specifications of five DATRAC converter models. Send for your copy . . . TODAY!

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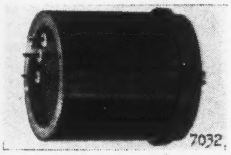
For more information circle **134** on inquiry card.

duty types are available from stock, offering 20°, 30°, 45° or 60° rotation. Typical intermittent (40%) duty model offers 12 lb-in torque at 115v. Solenoid closes in approximately 0.02 sec.—*Leetronics, Inc., Dept. 1-4, 30 Main St., Brooklyn 1, N. Y.*

For more information circle **474** on inquiry card.

P-M ALTERNATOR

New "Type PG-3323" permanent-magnet alternator has unusually high output for its size and weight. Size 1.6" D by 1.8"L, weight 8.5 oz, output 24 va per phase, 0.33 lagging power factor at 400 cps when driven at 12,000 rpm. (Other voltages and current also available, in single, 2- or 3-phase)—*John Oster Mfg. Co., Avionic Div., Racine, Wis.*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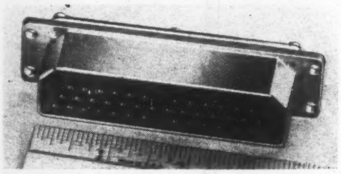
For more information circle **475** on inquiry card

CONNECTORS, etc.

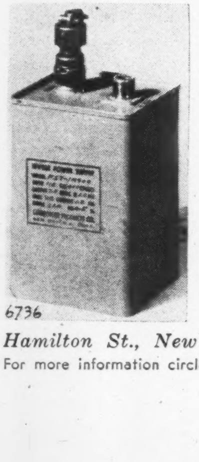
RACK & PANEL CONNECTOR

New "DPE" assembly is made up of forty 10-amp solder-pot contacts for No. 16 stranded wire, in a Melamine No. 1502; diecast aluminum shell protects both insert and contacts. Flashover is rated at 1700 vac 60 cps at sea level.—*Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.*



For more information circle **476** on inquiry card

SUPPLY INPUT PLUG

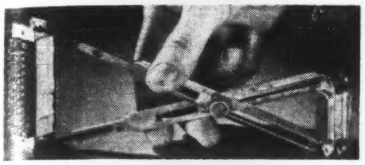

6736

New hermetically-sealed connector-type input plug for power supplies, cuts down number of leads to supply only two screw type connections (HV and LV); choice of two, three; or four pin contacts; meet MIL-C-5015B.—*Condenser Products Co., 140 Hamilton St., New Haven, Conn.*

For more information circle **477** on inquiry card.

RIBBON-DESIGN CONNECTORS

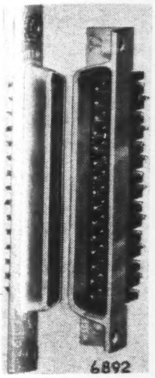
New "Amphenol Micro-Ribbon" miniaturized connectors utilize an improved version of maker's "ribbon"



c ntact design with self-wiping, self-c aning, double-contact action; "are o -third the weight and less than o -fourth the size of most standard c nnectors"; are available in 14, 24 a 1 36 contacts.—*American Phenolic (p., Chicago 50, Illinois.*

For more information circle **478** on inquiry card.

P INTED CIRCUIT CONNECTORS



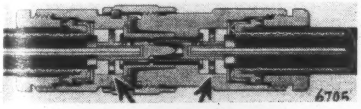
6892

New **"Series W"** connectors meet aircraft requirements for printed circuitry. Plug contains individually-isolated right-angled pin contacts: one end for dip soldering to printed circuit board, the other end for engaging socket contacts of mating receptacle, which is used for attaching external wires. Available with 7, 11, 15, 19 or 23 contacts.—*Dep't R, W nchester Electronics, Inc., Norwalk, Conn.*

F more information circle **479** on inquiry card.

RF CONNECTOR

New RF connector design features a contact "captivated" within connector shell for assured circuit continuity



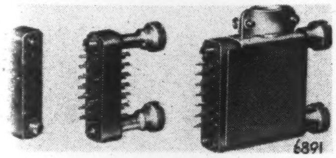
6705

un er great extremes of temperature fl ctuation. By anchoring contact wi hin connector shell, contacts rem n fixed in position even when diele tric shrinks.—*American Phenolic C p., Chicago 50, Illinois.*

F more information circle **480** on inquiry card.

LOCKING DEVICE

ew jackscrew locking device enab s vibration-proof coupling of minia re-connector plug and receptacle,



6891

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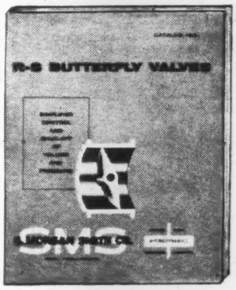
BUTTERFLY VALVES

When the delivery date is important, you can get faster service on standard R-S Butterfly Valves. Based on the results of previous experience, R-S Valves are now standardized. All components for those most commonly used, in sizes from 4" to 48", are carried in stock, ready for assembly.

R-S Butterfly Valves give you positive, dependable performance. You get the advantages of:

- complete control in all positions of normal regulating range.
- fast regulation and closure.
- minimum pressure drop that saves power.
- compactness and light weight at less cost.



This new catalog will give you complete dimensions, specifications, layout drawings and materials for all R-S Butterfly Valves in the pressure ratings that have been standardized to date. As others are added, new sections will be published. To get a free copy and assure yourself of future sections, contact your SMS representative, or write to S. Morgan Smith Company, York, Pennsylvania.

HYDRAULIC TURBINES
PUMPS
GATES & HOISTS
TRASH RAKES
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HYDRODYNAMICS

ROTOVALVES
BALL VALVES
BUTTERFLY VALVES
FREE-DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS

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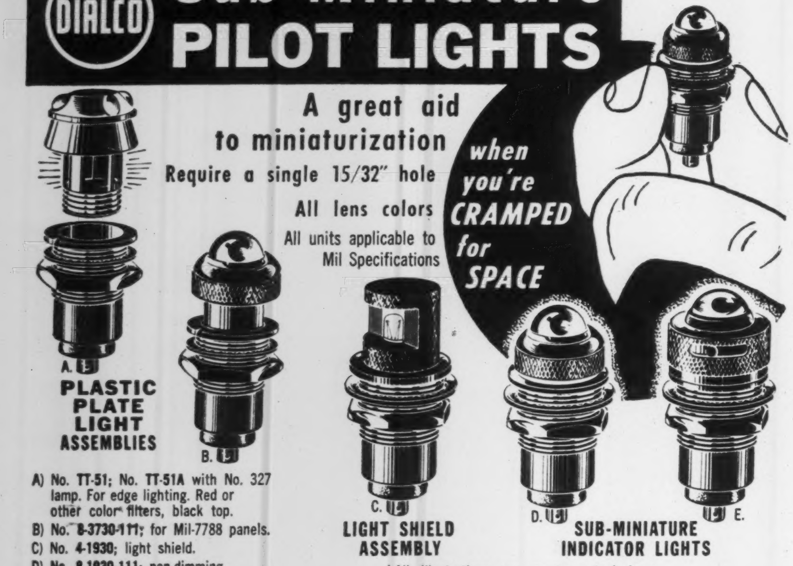
For more information circle **135** on inquiry card.



DIALCO

Sub-Miniature
PILOT LIGHTS

A great aid
to miniaturization

Require a single 15/32" hole

All lens colors

All units applicable to
Mil Specifications

when you're CRAMPED for SPACE

PLASTIC PLATE LIGHT ASSEMBLIES

LIGHT SHIELD ASSEMBLY

SUB-MINIATURE INDICATOR LIGHTS

A) No. TT-51; No. TT-51A with No. 327 lamp. For edge lighting. Red or other color filters, black top.
B) No. 8-3730-111; for Mil-7788 panels.
C) No. 4-1930; light shield.
D) No. 8-1930-111; non-dimming.
E) No. 11-1930-111; mechanical dimmer.
No. 3-1930-111; polaroid dimmer.

(All illustrations are approx. actual size.)

All assemblies accommodate midget flanged base lamps like this one (*actual size*); easily replaced. Available for voltages of 1.3, 2.7, 6, 14, and 28.

Any assembly available complete with lamp.

SAMPLES ON REQUEST — NO CHARGE

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Foremost Manufacturer of Pilot Lights

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CORPORATION
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For more information circle **136** on inquiry card.

The "darkroom" you carry with you . . . !

Consolidated Type 23-109
OSCILLOGRAM PROCESSOR

Use it anywhere . . . it needs neither water connections nor darkroom . . . automatically delivers a developed, dried oscillogram to you in mere minutes. The hundreds now in use are saving processing time . . . are reducing that vital gap between the test and data availability.

You needn't have great numbers of oscillograph records to justify a CEC processor. Because it will take the entire contents of an oscillograph magazine, it's equally valuable for test programs consisting only of occasional, long-duration runs. Extremely simple, it can be operated even by inexperienced personnel.

- *portable, automatic*
- *250-ft. record capacity*
- *thermostatic control*
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CEC 1537B-X10

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ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena, California
Sales and Service Offices Located in: *Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.*

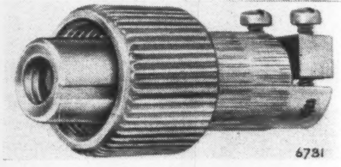
For more information circle **137** on inquiry card.

while providing (1) ease of screw-thread action for their connection and separation and (2) positive connector polarization. Aircraft requirements are met by safety wiring provision and self-locking pins instead of setscrews.—*Dep't R, Winchester Electronics, Inc., Norwalk, Conn.*

For more information circle **481** on inquiry card.

HIGH TEMPERATURE CONNECTOR

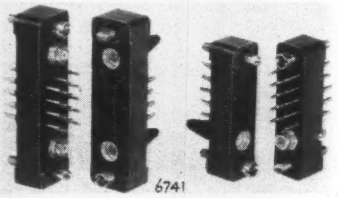
New "GHR1F-H," for installation on fire-detection systems in aircraft or for high-temperature missile applications, withstands temperatures up to 2000°F; has contacts designed for all conditions of stress and vibration. —*Gorn Electric Co., Inc., Electronic Div., Stamford, Conn.*



For more information circle **482** on inquiry card.

MINIATURE CONNECTOR

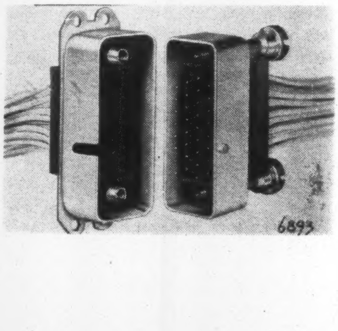
New 50-ohm matched impedance coaxial contacts are now available in an insert arrangement with "Series 20" miniature "Continental" connectors; provides space-saving. Standard contact arrangements for 14 and 18 contacts. Others for special circuit requirements.—*Electronic Sales Division, DeJur-Amsco Corp. 45-01 Northern Blvd., Long Island City 1, N. Y.*



For more information circle **483** on inquiry card.

MINIATURE CONNECTORS

New "XMRE" miniature connectors for users of AN-type connectors who require rugged but more space-conserving lighter-weight units, have polarized aluminum shells to provide protection for dielectric and contacts;

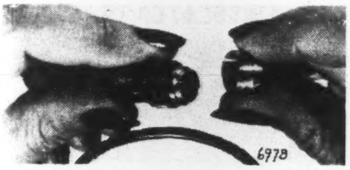


connectors come in many assembly combinations, including various accessories.—*Dep't R, Winchester Electronics, Inc., Norwalk, Conn.*

For more information circle **484** on inquiry card.

SUBMINIATURE CONNECTORS

New "Type C-21 Glennite" connectors are said to be the smallest and lightest (0.565" dia, 1" long) shielded

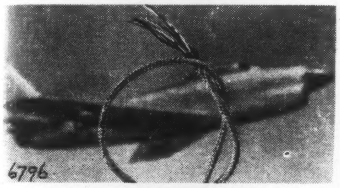


case types adaptable for use with up to 5 pins. Size and weight reduction is accomplished by eliminating conventional external cable clamp. Units can repeatedly withstand 100 *G* shock. Up to 25 lb tension can be applied to cable without strain on connector pins. ★Matching "C-21" coaxial cables, 0.14" dia, have high-temperature plastic outer jacket, operate dependably to 105°C.—*Gulton Mfg. Corp., Metuchen, N. J.*

For more information circle **485** on inquiry card.

MINIATURE HI-TEMP CABLES

New miniature multi-conductor shielded and jacketed cables are available to 24-conductor assemblies. Each

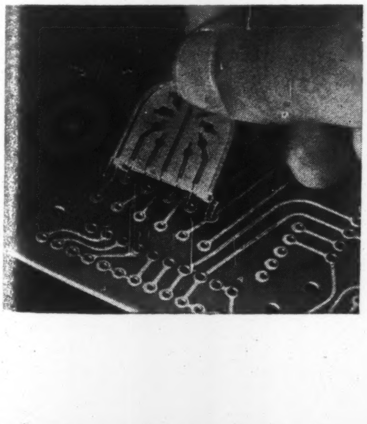


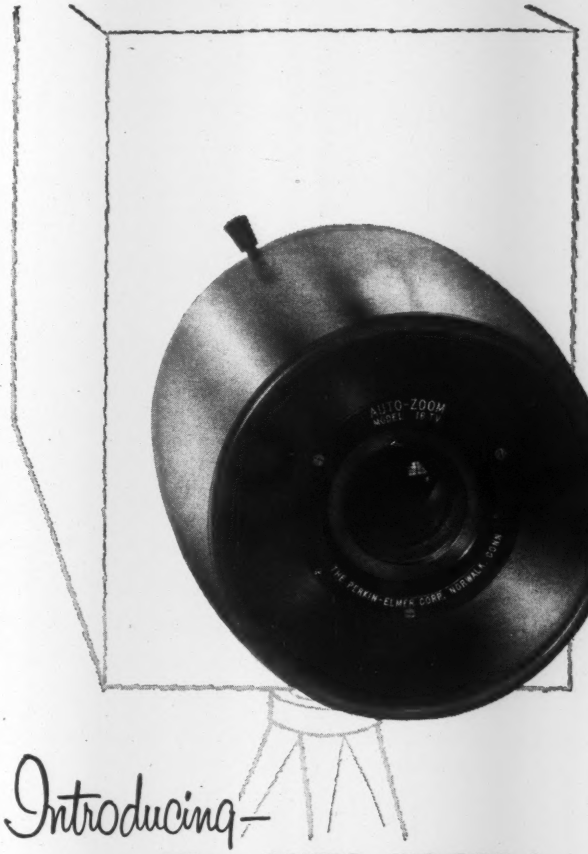
conductor conforms to MIL-W-16878 for type E and EE, and can be obtained in solid colors or a wide variety of spiral striped color codings; outer jackets Teflon, Kel-F, or a glass fibre braid.—*Hitemp Wires, Inc., 26 Windsor Ave., Mineola, N. Y.*

For more information circle **486** on inquiry card.

RIGHT-ANGLE TUBE SOCKETS

New right-angle tube sockets permit mounting tubes parallel to printed-wiring boards by means of right-





Introducing—

The AUTO-ZOOM lens
. . . for Vidicon TV Cameras

- **5 to 1 Variable Focal Length (10 to 1 with a simple lens change).**
- **Completely motorized. Zoom, focus and iris remotely controlled.**
- **Fills Vidicon format. No vignetting as with standard 16mm movie lens.**

The AUTO-ZOOM TV16 is a high resolution, 5 to 1 variable focal length lens for use with Vidicon TV cameras. Its remote control, motor-driven focus and zoom permit smooth, steady tracking with sharp focus throughout the entire range. The AUTO-ZOOM lens system is fully corrected and suitable for color television work.

One Camera Does The Work Of Two — A single stationary TV camera equipped with the new AUTO-ZOOM lens can go from wide angle distance shot to telephoto close-up—smoothly, quickly, automatically . . . without loss of focus or change of lens. With AUTO-ZOOM, one camera provides the near-far coverage normally supplied by two cameras with conventional lenses.

Coupled with the new high quality Vidicon type cameras now coming on the market, the AUTO-ZOOM greatly extends the usefulness of low-cost industrial and broadcast TV equipment. The AUTO-ZOOM TV16 is a product of Perkin-Elmer, world leader in optical and electronic instrument research and development.

Ask your camera manufacturer for further information or write Perkin-Elmer for a descriptive brochure.

The AUTO-ZOOM TV16 mounts easily on any standard Vidicon television camera

Specifications

Focal Length: 5 to 1 ratio. 30mm to 150mm, standard. 60mm to 300mm with optional accessory lens.

Aperture: Maximum opening f/2.7 from 30mm to 80mm focal length. Decreases to f/4.7 at 150mm. Aperture is automatically held constant throughout range at any opening f/4.7 or smaller. Minimum opening f/11.

Resolution: Better than 500 TV lines.

Field Size: Covers the full field of the Vidicon without vignetting at the corners.

Object distance: Six feet to infinity.

Perkin-Elmer CORPORATION
NORWALK, CONNECTICUT

For more information circle **138** on inquiry card.

the new
Cary

MODEL 31
Vibrating Reed Electrometer

Detects current as small as 1.0x10-17 amperes...charges as small as 5x10-16 coulombs...voltages as small as 0.02 mv!

Applications of the Cary Model 31 include measurement of radioactivity, determination of C14, H3 and S35 concentrations, amplifications and measurement of ion currents in mass spectrometry, pH determinations, measurements of electrical properties . . . where precise measurement of small charges, currents, or voltages from a high impedance source is required.

Stability—Open circuit input: less than 6x10-16 coulombs rms short period noise; less than 5x10-17 amperes steady drift. Short circuit input: less than 0.02 mv rms short period noise; less than 0.2 mv per day steady drift.

Accuracy—Measurements reproducible to within 1%. Accuracy limited only by the accuracy of the recorder, potentiometer, or meter used.

Reliability—No grid current, greater freedom from zero drift. Much more rugged than other types with comparable sensitivity.

Easy to set-up and adjust—Requires no leveling or special vibration supports.

10 standard ranges—1, 3, 10, 30, 100, 300, 1,000 mv, and 3, 10, 30 volts.

Accessories—Special adapters, chambers, a multi-range recorder and other accessories are available.

A new catalog on the Cary Model 31 is available. Write for your copy today.

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362 W. Colorado St., Pasadena, California

For more information circle **139** on inquiry card.

479® PLATINUM ALLOY POTENTIOMETER RESISTANCE WIRE

- HIGH TENSILE STRENGTH
  To permit easy winding of Potentiometers and Coils.
- CORROSION RESISTANT
  Platinum Content provides unsurpassed resistance to corrosion . . long shelf life.
- MAXIMUM STABILITY
  of Electrical Characteristics. Available Bare or Enameled as small as .0004" diameter to as large as required. Resistance to 2500 ohms ft.

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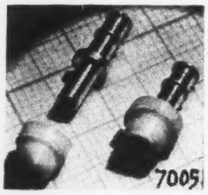
For more information circle **140** on inquiry card.

angle tube sockets; reduce height and depth of assemblies; are equally adaptable to hand- or machine-insertion methods; are available in 7- and 9-pin sockets and in four types.—*Pacific Div., Aerovox, 2724 S. Peck St., Monrovia, Calif.*

For more information circle **487** on inquiry card.

TEFLON INSULATED TERMINALS

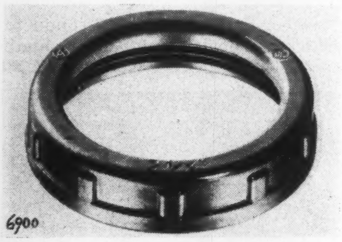

7005

New Teflon-insulated terminals utilize a new principle which eliminates terminal boards: Teflon sleeve is locked into metal chassis and terminal then swaged into sleeve. Use of metal chassis as base for terminal obviates need for insulated terminal boards.—*Lerco Electronics, Inc., 501 S. Varney St., Burbank, Calif.*

For more information circle **488** on inquiry card.

INSULATING BUSHINGS

New Polyester Glass Insulating (Pegi) conduit bushings, available for all conduit sizes, are UL listed; withstand high temperatures; are self-extinguishing after being exposed to flame; and show practically no water absorption.—*Adalet Mfg. Co., Cleveland 11, Ohio.*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For more information circle **489** on inquiry card.

MECHANICAL COMPONENTS

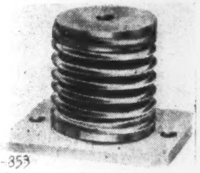
NYLON SCREWS AND NUTS

6886

New 1" lengths are added to fractional-inch lengths of molded black Nylon screws, in flat and round head, in 6-32, 8-32, 10-32 and ¼-20 sizes. Also added, in round head types, are ½" lengths in both ¼-20 and 4-40; and 1½" lengths in both 8-32 and 10-32 sizes. Advantages include insulation qualities (no washers or bushings needed), and resistance to corrosion. —*Dep't IUP, Weckesser Co., 5261 No. Avondale Ave., Chicago 30, Ill.*

For more information circle **490** on inquiry card.

LOW-FREQUENCY MOUNTS



New "W227" unit mounts control low-frequency vibration disturbance common to industrial and laboratory equipment; use 'Met-L-Flex" elements providing effective resilience with an unusually high degree of damping; are designed for a static load deflection of 2½"; overload protection built-in.—*Robinson Aviation, Inc., Teterboro, N. J.*

r more information circle **491** on inquiry card.

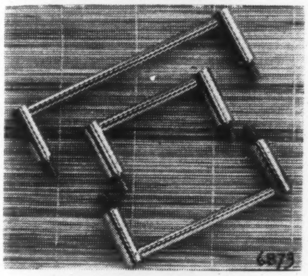
COMPONENT HANGERS

New "Type S1" precision component mounting hangers, immediately available from stock, have been designed to mount almost all widely-used rotating components such as Helipots," Kearfott, Transicoil, Ke-ay, Diehl and Arma motors, Kollsman motors & generators, "Micro-ots," Bendix "Autosyns," etc. Material is cast aluminum and finished chromic acid anodized per military specs.—*PIC Design Corp., 160 Atlantic Ave., Lynbrook, L. I., N. Y.*

more information circle **492** on inquiry card.

INSTRUMENT HANDLE

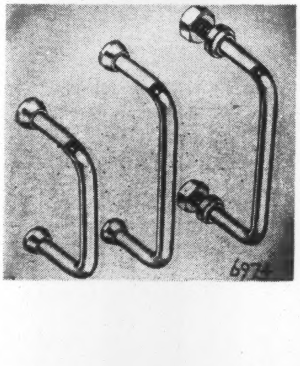
New "Model 1030" economy adjustable instrument handle has center crossbar available in lengths from 3" to 6" in increments of ⅛". Handles are nickel-plated brass; other finishes available.—*U. S. Engineering Co., Inc.*, 521 *Commercial St., Glendale* 3, *alif.*



more information circle **493** on inquiry card.

PANEL HANDLES

New panel handles are made of half-hard brass with a polished nickel-plated finish; are available in



Now *simpler, more accurate control of oxygen in*

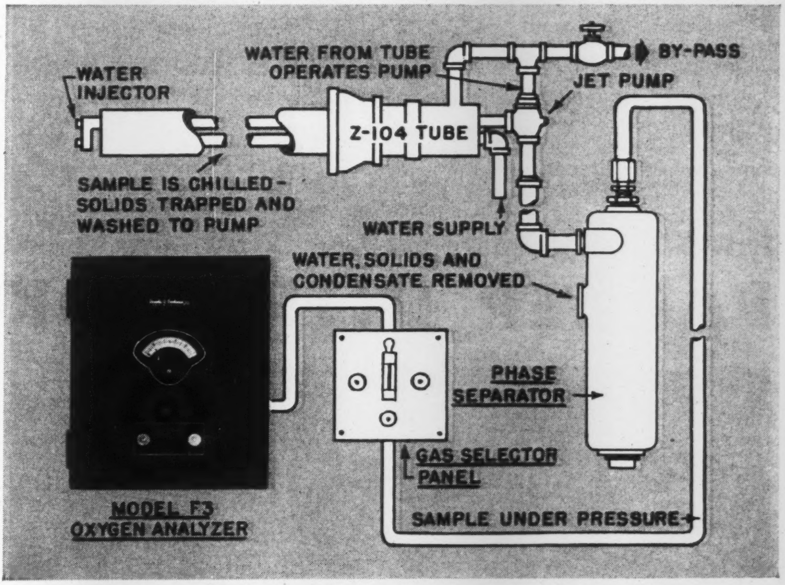
BOILERS...FURNACES...KILNS...DIRECT-FIRED HEATERS, ETC.

with Arnold O. Beckman INC.

complete Analysis Systems!

Arnold O. Beckman, Inc. – leaders in developing advanced instrumentation for accurate oxygen control – now offers *complete* analysis systems for higher combustion efficiencies at lower fuel costs.

These field-proven systems are already being used by progressive operators to boost profits, cut costs – and they will make the same savings for *you*. They consist of Analyzer, and Sampling System – all in one compact installation suitable for indoor or outdoor location. For severe temperature conditions, heated cabinets can be supplied.



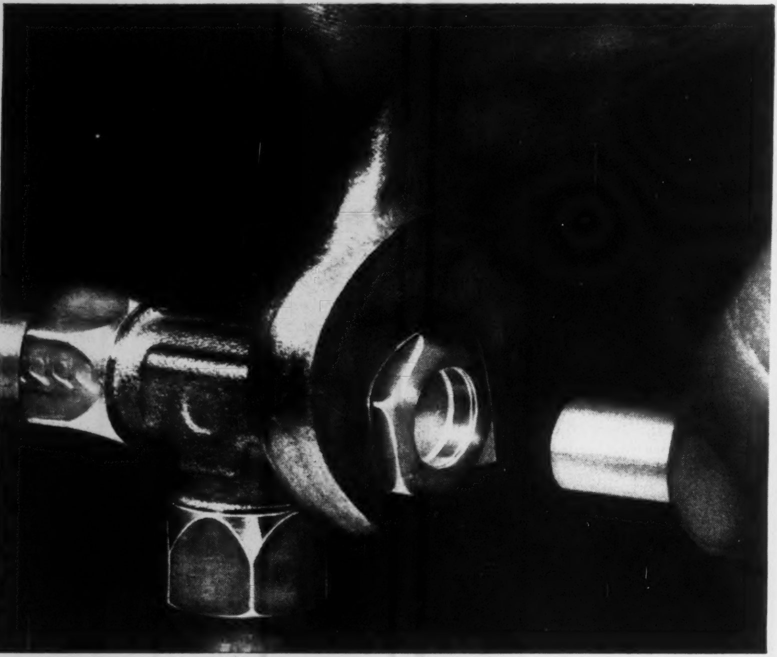
The diagram (above) shows a typical analysis system for boilers. The incoming sample gas is first chilled and washed . . . then passes through a Separator where the condensables and solids are removed. The resulting clean, dry sample gas flows under pressure to the Gas Selector Panel (for selecting "Zero," "Span" and "Sample" gases) . . . then into the Analyzer where the oxygen content is quickly measured. The Analyzer may be used with any standard recorder or controller.

Result – new speed, simplicity and accuracy in controlling air-fuel ratios, with important savings in fuel and operating costs!

Get the full story on these Complete Analysis Systems by writing for Data File #19G-56.

Arnold O. Beckman INC
ANALYZERS
Profit Builders for Industry
1020 Mission Street
South Pasadena, California

For more information circle **141** on inquiry card.



Simply push, then tighten! Anyone can quickly install all-new, *lightweight Intru-lok* tube fittings . . . the proven Parker 3-piece flareless design. Just insert the tube, then tighten the nut with a regular wrench . . . for a leakproof, vibration-proof joint. Made of brass for copper or nylon tubing. Send for complete details in Catalog 4324.

Introducing easy-to-use

PARKER INTRU-LOK

For soft plastic tubing you use knurled nut and expander insert with new *Intru-lok* body. Joints can be disconnected and reassembled. Complete details in Catalog 4324. Send for it.

Weld-lok fittings; for extreme temperatures, corrosion conditions . . . machined from high-quality steel or stainless bar stock and forgings . . . for tubing ¼″ through 2″ O.D.

TUBE AND HOSE FITTINGS DIVISION
Section 415-Q
The Parker Appliance Company • 17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid
system components

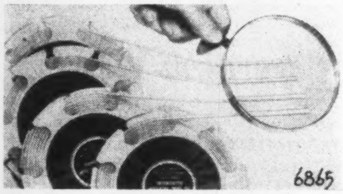
For more information circle **142** on inquiry card.

threaded type, which includes a threaded washer and a hex nut; also in a variety of sizes that contain #10-32 tapped holes for installation. (Ferrules for latter are extra.)—*Dept. P, Goe Engineering*, 219 *S. Mednik Ave., Los Angeles* 22, *Calif.*

For more information circle **474** on inquiry card.

HIGH-TEMP TEFLON TUBING

New "Tensolon" Teflon spaghett tubing is said to be the ideal sleevin

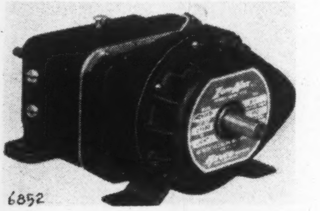


for wiring applications where hig temperatures (to 250°C) are encountered. It is available in AWG size 10 to 26, in natural and 9 solid colors —*Tensolite Insulated Wire Co., Inc.* 198 *Main St., Tarrytown, N. Y.*

For more information circle **495** on inquiry car

VARIABLE GEAR REDUCTION

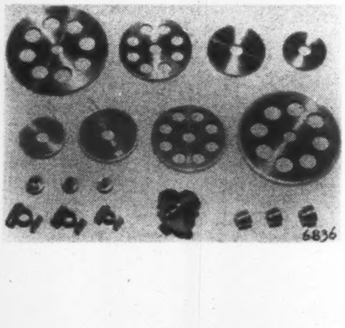
New "Zero-Max" transmission is a gear reducer with infinitely-variable speed form true zero to its maximum (80 rpm at 1750 rpm input). Speeds can be changed instantly whil unit is running or stopped. It is sai that unit develops constant torqu with exceptionally accurate spee control. Gear reductions of 2, 3, 4 an 5 to 1 that develop 20 to 100 pound-inches of torque are available.—*Re co, Inc.*, 1900 *Lyndale Ave. So., Mi neapolis, Minn.*



For more information circle **496** on inquiry car

SPUR GEAR BLANKS & HUBS

New "Type #J" precision spu gear blanks are immediately availabl from stock in #303 stainless stee

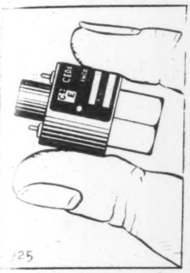


(clear passivated) or 24ST aluminum (chromic acid anodized) before cutting. Gears are stocked in 48, 64, 72 & 96 pitches 20° pressure angle, 14¼° pressure angle on request. Pin hubs are stainless steel (clear passivated) with SS setscrews.—*PIC Design Corp., 160 Atlantic Ave., Lynbrook, L. I., N. Y.*

For more information circle **497** on inquiry card.

VALVES

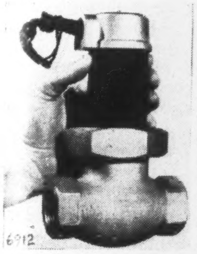
SOLENOID VALVE



New subminiature straight-through solenoid valve designed for guided-missile and aircraft control applications is available in a variety of fittings, normally opened or normally closed, for continuous duty on either ac or dc. 2.2 watts; 30 psi to 30" Hg.—*Dep't A, Cedar Engineering, Inc., 5806 W. 36th St., Minneapolis 16, Minn.*

For more information circle **493** on inquiry card.

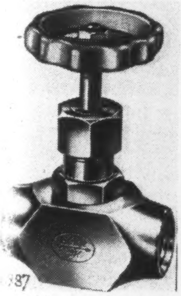
SOLENOID VALVE



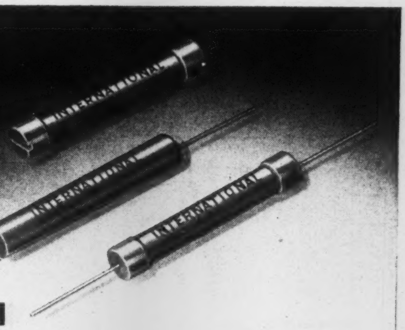
New 1" stainless-steel two-way globe-type pilot-operated solenoid valve with packless construction is available in any voltage. Two variations: "Type SS" with a standard coil, for operation to 300 psi; "HPSS" with a high-pull coil, to 1,500 psi. Among features: high corrosive resistance; full-ported construction allowing maximal flow-rate at maximal rated pressure.—*Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis, Ind.*

For more information circle **499** on inquiry card.

NEEDLE VALVES



New steel-bodied bar stock needle valves, available in sizes from ⅛" to ½" in straight or angle patterns, can be supplied with either O-ring seals or conventional packing. O-ring style is particularly applicable to test-panel high-pressure air or hydraulic service and, if helium leak-tested, can be used for high-vacuum service. Bar stock valves



Operating temperature range from −65° to +100° C

International selenium cartridge rectifiers

Designed for long life and dependability, these high voltage cartridge rectifiers contain the most reliable components known to the industry. Completely shock resistant, they are ideally suited for compact, low current applications. 3 types: Phenolic Cartridge; Moisture sealed; Hermetically sealed. Current ratings from 200 microamperes to 100 milliamperes. Output voltage ratings up to 6,000 volts per cartridge.

A WORLD OF DIFFERENCE . . . THROUGH RESEARCH

International Rectifier
CORPORATION
EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

For more information circle **143** on inquiry card.

still going... Strong!

SERIES K15300 D.C.

AN TYPE MOUNTING

THE A. W. HAYDON COMPANY STOP CLOCKS

withstand rugged conditions, voltage and temperature variations, with unfailing performance. Used where time intervals must be accurately measured and electrical reset is desired.

SPECIFICATIONS: Voltage Range—Motor and Clutch Coil: 20-30 Volts D.C. • Temperature Range—From —55°C. to 85°C. • Maximum Current Requirement—475 Milliamps at —55°C. and 30 Volts D.C. • Accuracy— ± 0.10% of reading ± 20ms @ 20°C. ± 0.20% of reading ± 20ms from —55°C. to 85°C. • Reset Time—2 seconds maximum • Dielectric Test—140 Volts RMS-60 CPS or 200 Volts D.C. for 1 minute.

Meet military specifications. Hermetically sealed enclosure and connector. AN connector or glass metal header optional. Choice of flange mountings. Electrical reset permits local or remote control.

GENERAL CATALOG SENT ON REQUEST

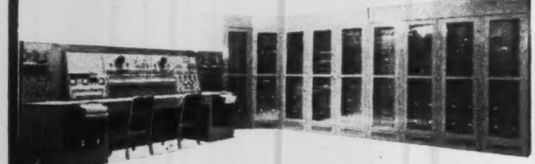
PREFERRED WHERE PERFORMANCE IS PARAMOUNT

The A.W. HAYDON Company
228 NORTH ELM STREET, WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

For more information circle **144** on inquiry card.

you can't afford to "do it yourself"

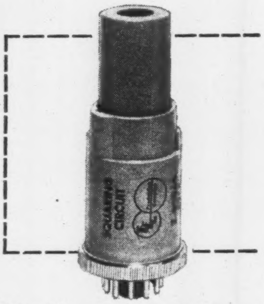
Where custom systems are involved, it just doesn't pay to do the work yourself. Not when EECO can do it for you—expertly, efficiently—without disrupting the normal productive activities of your engineering staff. Major EECO installations in operation in all parts of the country are proof of Electronic Engineering Company's ability to design and produce anything from single-rack recording systems to the most complex multi-console master installations. And EECO design techniques, perfected through years of systems work, are now ready to be put to work for you in an EECO engineered system to meet your exact requirements.



One wing of the EECO Central Dual Timing System at Patrick Air Force Base, Florida. This system is a master time signal generating installation for the base and ties in with all instrumentation operations for guided missile testing.

PLUG-IN CIRCUITS

...your key to lower design and production costs. These EECO plug-ins have proven themselves in scores of major installations...the one above contains more than 2,500 units. Originally designed for EECO systems, these packaged circuits are now available to you. Complete data on standard and custom circuits in catalog H-3.



ELECTRONIC ENGINEERS AND PHYSICISTS — EECO offers unusual career opportunities for advancement and professional growth in the creative field of systems and related electronic projects. Send resume to the attention of R. F. Lander.

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For more information circle 145 on inquiry card.

with carbon steel bonnets and SS bodies can be ordered for instrument panel mounting, with black plastic handwheel.—*Hoke, Inc., 231 So. Dean St., Englewood, N. J.*

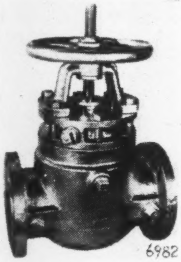
For more information circle **500** on inquiry card.

FLOW-CONTROL ATTACHMENT FOR CYLINDER CONTROL

New attachment for "Speed King" valves affords precise variation and control of cylinder operating speeds; functions by restricting stem travel, thus regulating flow through valve to and from cylinder. Threaded stop screws at either end of the valve body provide a complete range of flow control, from fully restricted to full open, in both directions.—*Valvair Corp.,* 454 *Morgan Ave., Akron* 1, *Ohio.*

For more information circle **501** on inquiry card.

JACKETED GATE VALVE

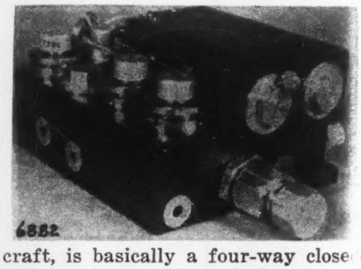


New "All-Jacketed" gate valve does not need to be removed from process line to remachine seat. Replacement inserts can be installed in minutes, minimizing shut-down time. Line size 1½" to 4" available in cast iron, steel, bronze, Ni-Resist and stainless steel. Valves in line sizes 6" to 10" are made of fabricated steel or stainless steel.—*Hetherington & Berner Inc.,* 701-745 *Kentucky Ave., Indianapolis* 7, *Ind.*

For more information circle **502** on inquiry card.

SELECTOR VALVE ASSEMBLY

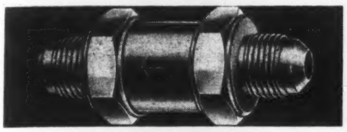
New oil-hydraulic solenoid selector valve, for use with on-off (contactor) type servomechanism controls in aircraft, is basically a four-way closed-center selector valve, designed as a packaged unit containing (1) restrictor and by-pass valve arrangement, (2) pressure relief valve, (3) two thermal relief valves, (4) pressure switch, (5) electrical solenoid-operated shut-off valve and (6) check valve. It enables two-way actuation of controls at two different rates of response.—*Vickers, Inc., Detroit* 3, *Mich.*



For more information circle **503** on inquiry card.

CHECK VALVE

New low-cost but highly efficient check valve is primarily designed for application on high-pressure side of

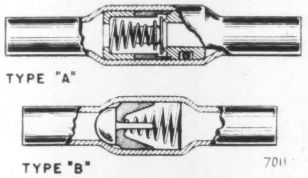


refrigerating and air conditioning systems, but can also be adapted for low side use. Standard body material is steel; also brass for low side applications where there is a chance of frosting or sweating. Seating plugs are made of nylon. Any end fittings can be provided.—*Remco, Inc., Zelienople, Pa.*

For more information circle **504** on inquiry card.

CHECK VALVES

New check valves feature a one-piece deformed tubular body that makes leakage and tampering impos-



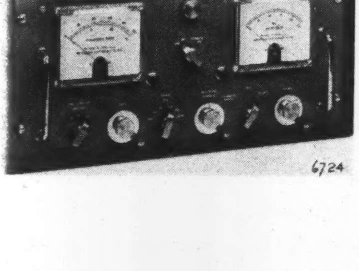
sible. Advantages are said to be small size and weight ratios to rated capacity, also reduced cost. Standard sizes to 1" are intended for medium- and low-pressure applications; capillary sizes for h-p. "Type A" can be supplied with cracking pressure down to 0.06 psi and leakage at absolute zero if required; "Type B" is intended for less critical service, volume production and lower price. Both operate in any position, for liquid or gas.—*MCD Mfg. Co., 3218-B. Barker Ave., New York 67, N. Y.*

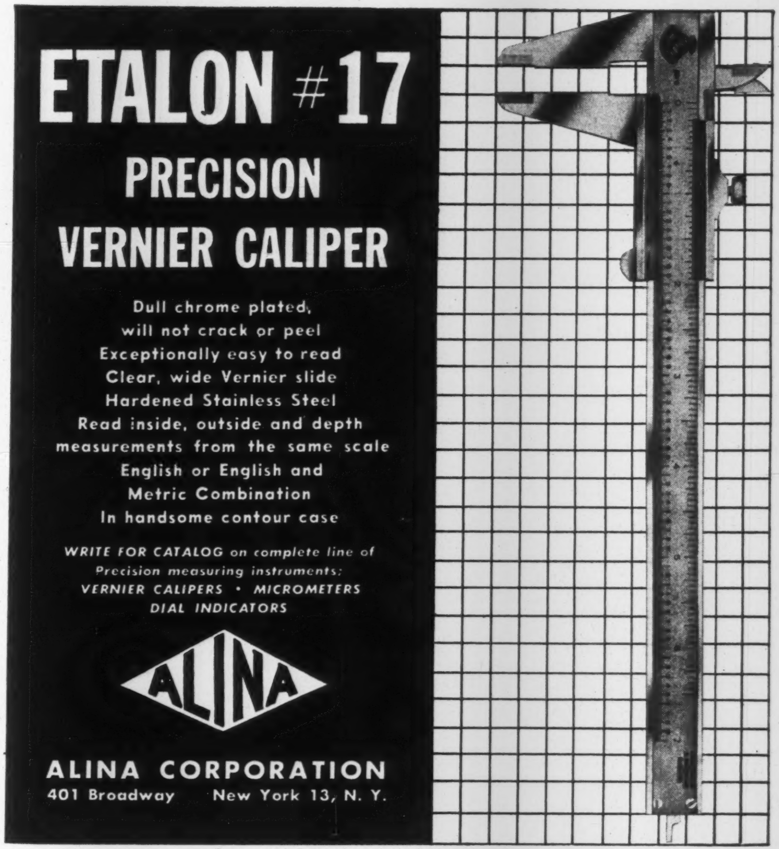
For more information circle **505** on inquiry card.

NUCLEONICS

COUNTING RATE METER

New industrial "Model 2850" for radiation levels features new circuitry; front-panel switches to select six ranges (300 to 100,000 counts per minute) and to select integrating time constant (2, 10 and 50 seconds); loudspeaker and volume control; special controls to permit direct meas-

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accurate indication
of 0.0002% oxygen,
0.0004% hydrogen
with the
Super-Sensitive
DEOXO INDICATOR

The measurement range of this super-sensitive equipment is from 0.0002% to 0.0200% (2 to 200 parts per million) oxygen and from 0.0004% to 0.0400% hydrogen. A dual range permits measurement of up to 0.5% oxygen or 1.0% hydrogen.

OTHER OUTSTANDING FEATURES:
- A self-contained calibrating unit and a recorder for a continuous, permanent record are included as integral parts of the unit.
- A recorder-controller can be supplied in place of the recorder, if desired.

Write for additional data, technical assistance.

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113 Astor St.,
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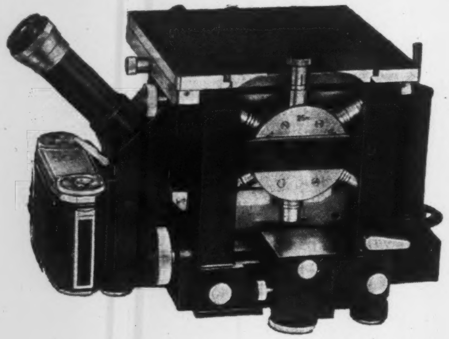

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For accurately measuring minute depths of roughness of super-finished surfaces, thicknesses of coatings, changes of surface structures due to wear, impact, stress, strain, corrosion, as well as for the studying of polished and etched metallurgical specimens.
Magnifications of 80x, 200x and 480x. Built-in Thallium and white light illuminators. Photography on 35mm film (1 x 1½-in.).

Write for free, detailed specifications

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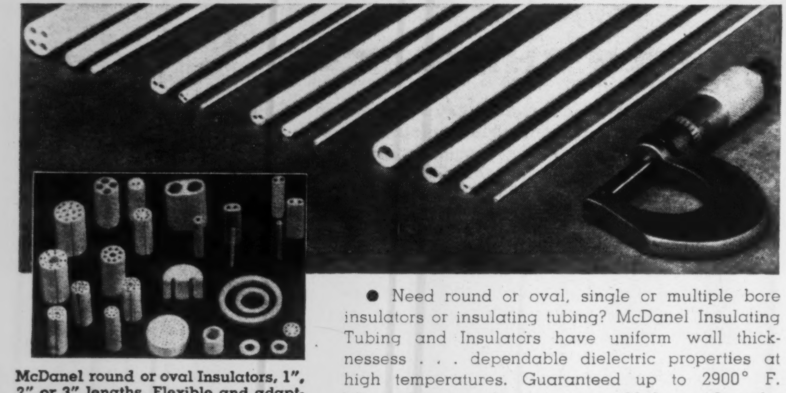

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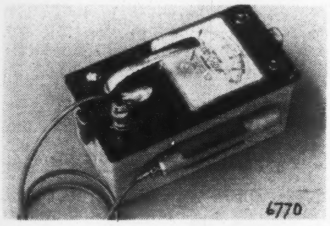
urement in percentages without calculations (can be locked for absolute calibration of all ranges); input sensitivity 0.25 v.—*Beckman Instruments, 2200 Wright Ave., Richmond 3, Calif.*

For more information circle **506** on inquiry card.

GEIGER COUNTER-SCALER

New "Count-O-Scope" portabl field scaler for radiation detectio and uranium prospecting registers o



6770

a 4-digit scaler the actual number o pulses received by Geiger tube ove an automatically timed 30- or 60-sec ond interval. In addition, it embodie a supersensitive linear two-rang ratemeter.—*Fisher Research Labora tory, Inc., Palo Alto, Calif.*

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NEUTRON ABSORPTION ANALYZER

6905

New Neutro Absorption Analyzer utilize principle of neutron absorptio to non-destructively, selectivel and rapidly detect and measur an element having a high absorption cros section in a sample or mixture o elments. B, Cd, In, Ir, Au, A and many rare earths can be measured for percent purity in a sample without need for chemical treatment at rate of about 60 per hour.—*American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Cali*

For more information circle **508** on inquiry card

AMPLIFIER-DISCRIMINATOR

New "Model N-301 Non-Overloa Amplifier and Integral Discriminator" is patterned after 1955 versio

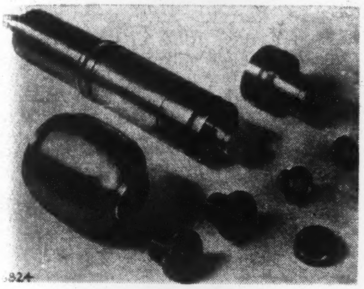
6979

of Higinbotham-Chase non-overload amplifier, employing long-tailed pair fedback loops. Gain is about 7,000; risetime 0.2 usec; low noise; overloads as large as 100× are handled easily. Instrument is excellent for such applications as scintillation spectroscopy.—*Hamner Electronics Co., Inc., P. O. Box 531, Princeton, N. J.*

For more information circle **509** on inquiry card.

SCINTILLATION DETECTOR

New "Model DS-5" is a completely new scintillation detector designed for efficient gamma-ray counting. A built-in preamplifier circuit provides a gain of 10 and a plateau in excess of 200 v for use with G-M scalers; or unit can be switched to a cathode follower output providing a gain of 1 for use in gamma ray spectrometry.—*Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*



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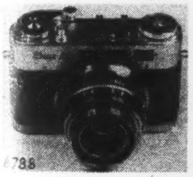
For more information circle **510** on inquiry card.

PHOTOGRAPHY

35-MM CAMERA

New "Diax II b," successsor to "Diax IIa," is said to incorporate "all advantages expected of top-bracket 35mm rangefinder cameras, but at a fraction of the price." A rapid one-stroke lever cocks shutter, advances film, and counts exposures. Seven interchangeable coated Schneider lenses with click stops, from 35mm f 3.5 wideangle to 135mm f/4 telephoto, all coupled to single-window superposed range/viewfinder; also a viewfinder for 85/90mm lenses built into camera body. —*Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.*



788

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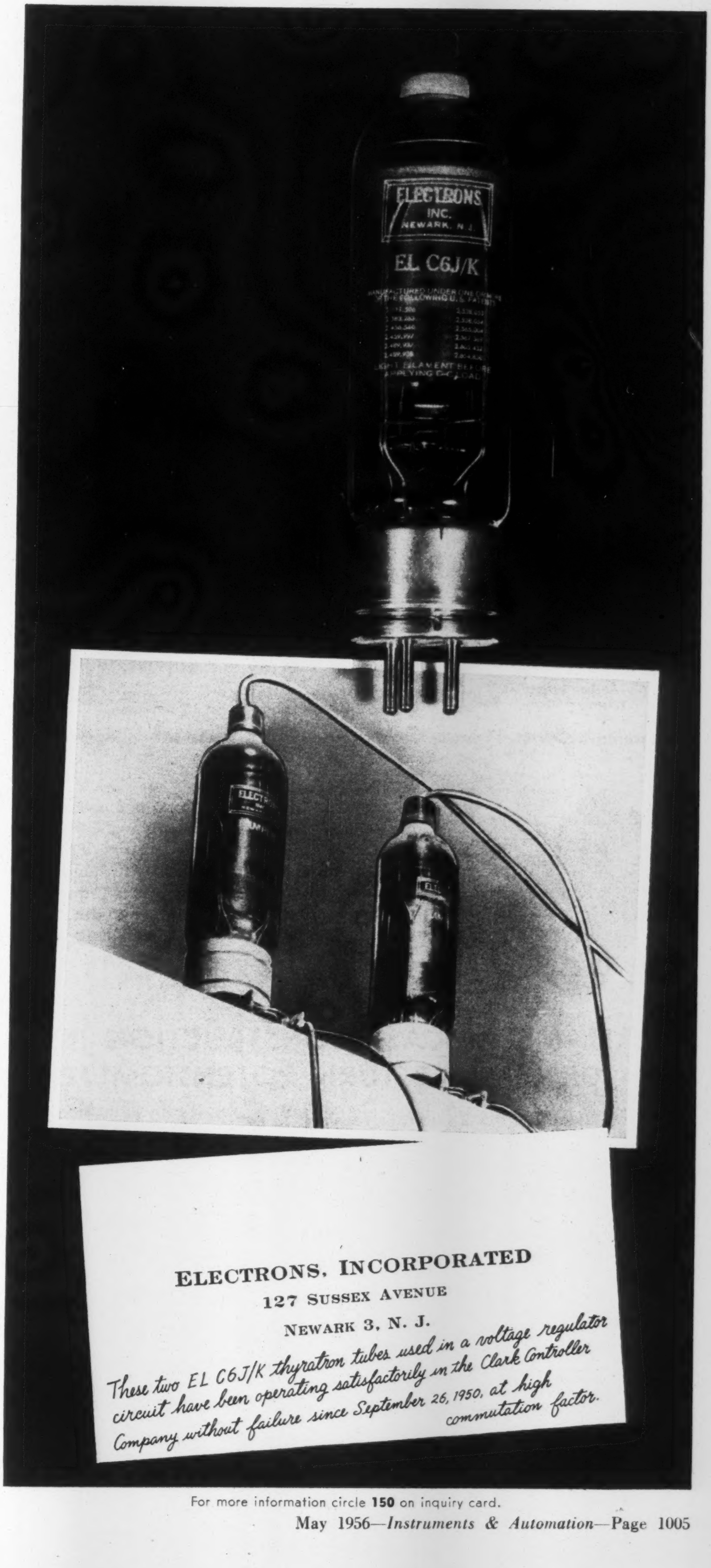
PHOTORECORDING PAPERS

New "Lino-Writ-2" medium-speed photographic recording paper featuring excellent blacks and whites, is supplied in splice-free rolls up to and including 400-ft lengths, in the same sizes and types as "High Speed Lino-



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These two EL C6J/K thyratron tubes used in a voltage regulator circuit have been operating satisfactorily in the Clark Controller Company without failure since September 26, 1950, at high commutation factor.

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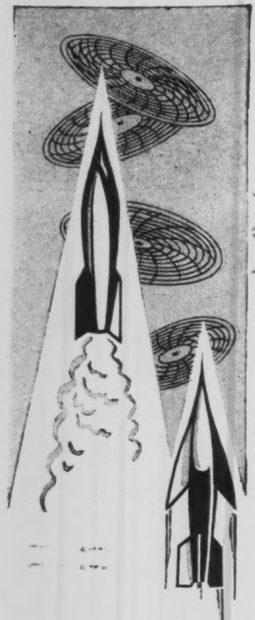

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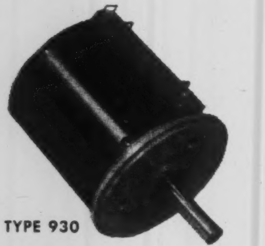

TYPE 930

Now, for the first time, the sustained accuracy of all-metal case construction is available in 10-turn and 3-turn potentiometers. These multi-turn units are capable of withstanding the severe environmental conditions required by military specifications and provide the user with high accuracy, reliability and long life.

ALL-METAL CASE CONSTRUCTION IN 10-TURN AND 3-TURN POTENTIOMETERS

The Types 930 and 933 are 1.812 in. diameter. In the Type 930 a linearity tolerance of ±0.05% is standard with linearity to ±0.025% for resistance of 2K ohms and greater. In the Type 933 the standard linearity tolerance is ±0.10%, with ±0.05% available in resistances of 10K ohms and above. Mechanical and electrical rotations are 3600° for Type 930, with standard tolerance of −0°, +4° or in special cases, −0°, +1°. For Type 933, rotations are 1080°, with standard tolerance of −0°, +4° and special tolerance of −0°, +1°. Furnished with all standard mountings. Flexibility of design makes it possible to supply many types of special mechanical and electrical features.

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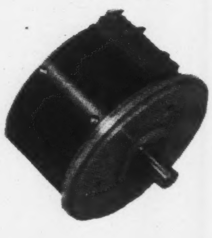


SAMPLES AVAILABLE ON ORDER

Fairchild's complete line can help solve all your precision potentiometer problems. For more information write Fairchild Controls Corporation, Components Division, 225 Park Avenue, Hicksville, L. I., N. Y. Dept. 140-65B2.

FAIRCHILD
PRECISION POTENTIOMETERS and COMPONENTS

For more information circle **152** on inquiry card.

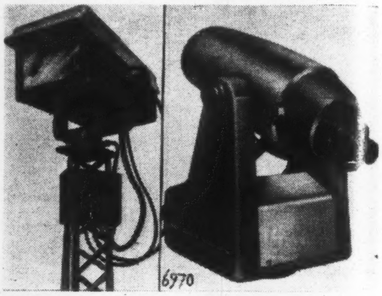
Writ" and regular "Lino-Writ" recording papers. ★"Lino-Writ-2 Type W," a thin 100% rag stock, will allow oscillographs using, for example, 125-ft rolls of ordinary paper to accept 200 ft of "Type W" paper.—*Photo Products Dep't, I. E. DuPont de Nemours & Co., Wilmington, Del.*

For more information circle **512** on inquiry card.

MISCELLANEOUS

REMOTE CONTROL ITV

New remote control of makers closed-circuit "ii-TV" (industrial and institutional) equipment including



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camera, lens iris and focus, indoor and outdoor pan and tilt, and weatherproof housing makes possible full 360° camera viewing and 90° tilt with indoor and otudoor mountings. Two restyled camera control units, portable and wall-mounted, are also available with plug-in control panels which can be removed to provide remote operation of beam, focus, target, blanking and gain.—*General Precision Lab., Inc., Pleasantville, N. Y.*

For more information circle **513** on inquiry card.

COLORED DRAFTING PENCIL

New "Mars-Lumochron" blueprints perfectly, greatly simplifies complicated technical drafting. Color drawings made with it are waterproof, erase perfectly, do not smear or fade. All 24 colors have the same degree of transparency under carbon-arc and mercury-vapor lamps, whence good blueprints. Each pencil will draw two miles of lines. Imported from Nurnberg, West Germany.—*J. S. Staedtler, Inc., Hackensack, N. J.*

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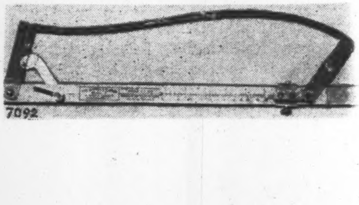
ADJUSTABLE CURVE

New "Model E" is first with interchangeable parts: no need to return to factory for repair. Length 14"; calibrated in actual inches of curvature and degree of curvature to scale



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of 1" = 100'; adjustable 0° to 7° and 8" to infinite radius.—*Albert G. Ingalls, 109 Chambers St., Winnsboro, S. C.*

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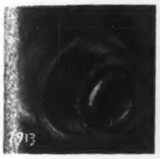
INCH CONVERTER

New "Calculaide" instantly converts into decimals or millimeters, and reveals corresponding U. S. standard gage numbers and drill numbers revealed; is a pocket-size instrument in which scales have been arranged for greatest user convenience and to prevent misreading.—*American Hydromath Corp., 25-20 43rd Ave., Long Island City 1, N. Y.*

For more information circle **516** on inquiry card.

SEAL FOR INDICATOR LIGHTS



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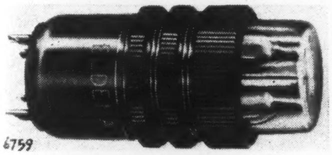
New "Series 4000" transparent high-pressure sealing boot fits standard AN indicator lights; is mounted by means of an adapter-nut which replaces standard panel mounting nut, is then installed over mounting nut and completely encloses signal light.—*Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N. Y.*

For more information circle **517** on inquiry card.

DUAL LAMP INDICATOR

New miniature "Model 1F" contains two independently wired bulbs and thus can indicate four different conditions; is 1.80" long and mounts in a 0.75" hole in panels up to 3/16" thick. Two neon or incandescent bulbs in amber, red, blue, green, or clear. —*Eldema Corp., 9844 Remer St., El Monte, Calif.*



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MINIATURE INDICATOR LAMPS FOR PRINTED CIRCUITS

New miniature indicator lamp assemblies feature major advancements in design, flexibility of use, rapid installation, and replaceability; occupy one-half to two-thirds less volume than other assemblies heretofore available: up to 1000 can be installed in a one-square-foot panel. Full range of voltages in either single-contact grounded models or with both terminals insulated; wide variety of lens designs; variations in color, trans-

6231 Actual Size

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Just a few of the many possibilities for use are: door chimes, laundry timers, depth finders, animated displays, heating controls, program clocks, fire alarm systems, integrators, time switches, chart drives, scoreboards, potentiometer drives. Motor may be mounted in any position. Wide selection of output speeds from 1800 to 1/6th RPM. Reversible and other models available. Send coupon for Bulletin No. 1055.

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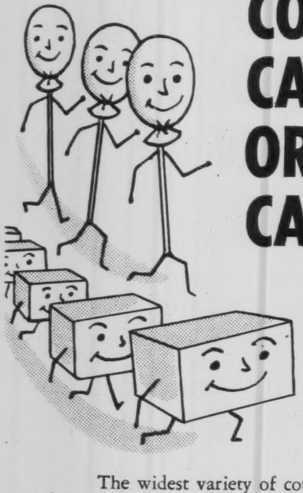
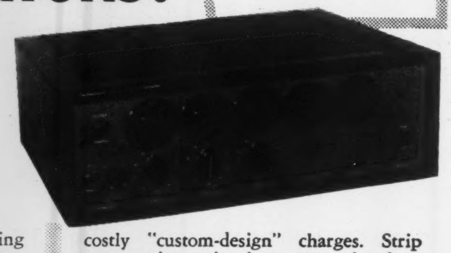


COUNT CANDY OR CARTONS?

there's an ATOMIC *counter or controller for the job*



The widest variety of counting models available . . . decade or duo-decade types . . . speeds up to 2000 c.p.s. for controllers, up to 20,000 c.p.s. for counters . . . straight totalizing counters, single or dual preset controllers provide wide versatility for production control.

Atomic's Functional Plug-In Strips provide complete instruments for specialized requirements . . . eliminate costly "custom-design" charges. Strip construction, using low-current, low-heat glow transfer tubes simplifies circuitry . . . provides extreme reliability. Plug-in replacement of strips eliminates downtime . . . keeps production rolling.

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parency, opaqueness, or with message indications. Pressure-loaded 24-carat gold contact springs and spring-steel cores.—*Circon Component Co., Santa Barbara Municipal Airport, Goleta, Calif.*

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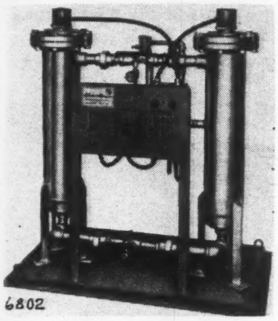
GAS DEHYDRATORS

New continuous dryers, designed to dehydrate compressed air and other gases to a dewpoint of −50°F or lower, automatically alternate compressed gas stream between twin adsorption towers: one dehydrates gas while adsorbent in the other is being reactivated, thus assuring continuous drying. Six standard models; specials for exceptionally high pressures.—*Kahn and Company, Inc.*, 543 *Windsor St., Hartford* 1, *Conn.*



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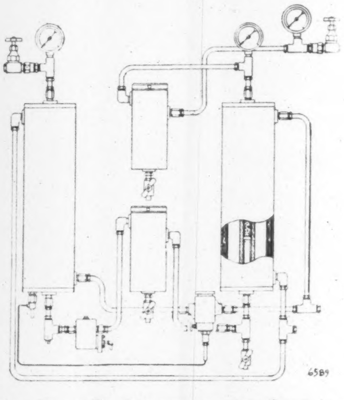
GAS DEHYDRATOR

New "Anhydryer" gives, for what is believed the first time, a constant dew-point reading at pressure directly on a gage. It removes water from air and other gases to any desired dew-point and removes oil vapor approaching 100%. Operation is automatic for continuous and/or intermittent drying. For either portable or stationary installations, high or low pressures and flows.—*Robbins and Associates*, 1735 *West Florence Ave., Los Angeles* 47, *Calif.*

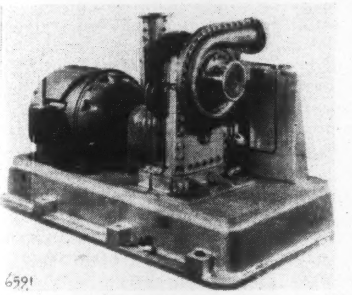


6589

For more information circle **521** on inquiry card.

INSTRUMENT-AIR COMPRESSOR

New centrifugal compressor furnishes clean oil-free air for use in instrument air systems (and for pro-

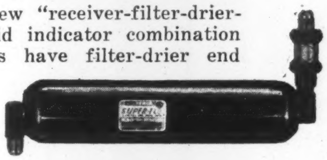


cess air) at flow-rates as low as 450 scfm delivered at 65 psia, requiring 128 hp. Unit pictured with 150-hp motor is capable of flows to 750 scfm at 65 psia. Additional models from 750 to 2000 scfm.—*Sawyer Bailey Corp., 1559 Niagara St., Buffalo 13, N. Y.*

For more information circle **522** on inquiry card.

RECEIVER-FILTER-DRIER-LIQUID INDICATOR

New "receiver-filter-drier-liquid indicator combination units have filter-drier end

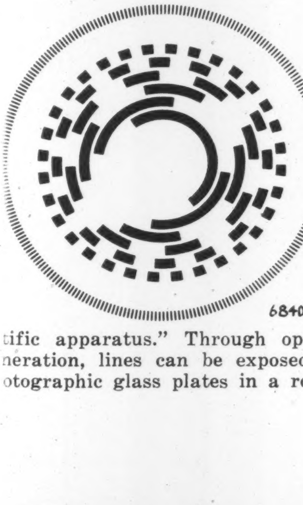


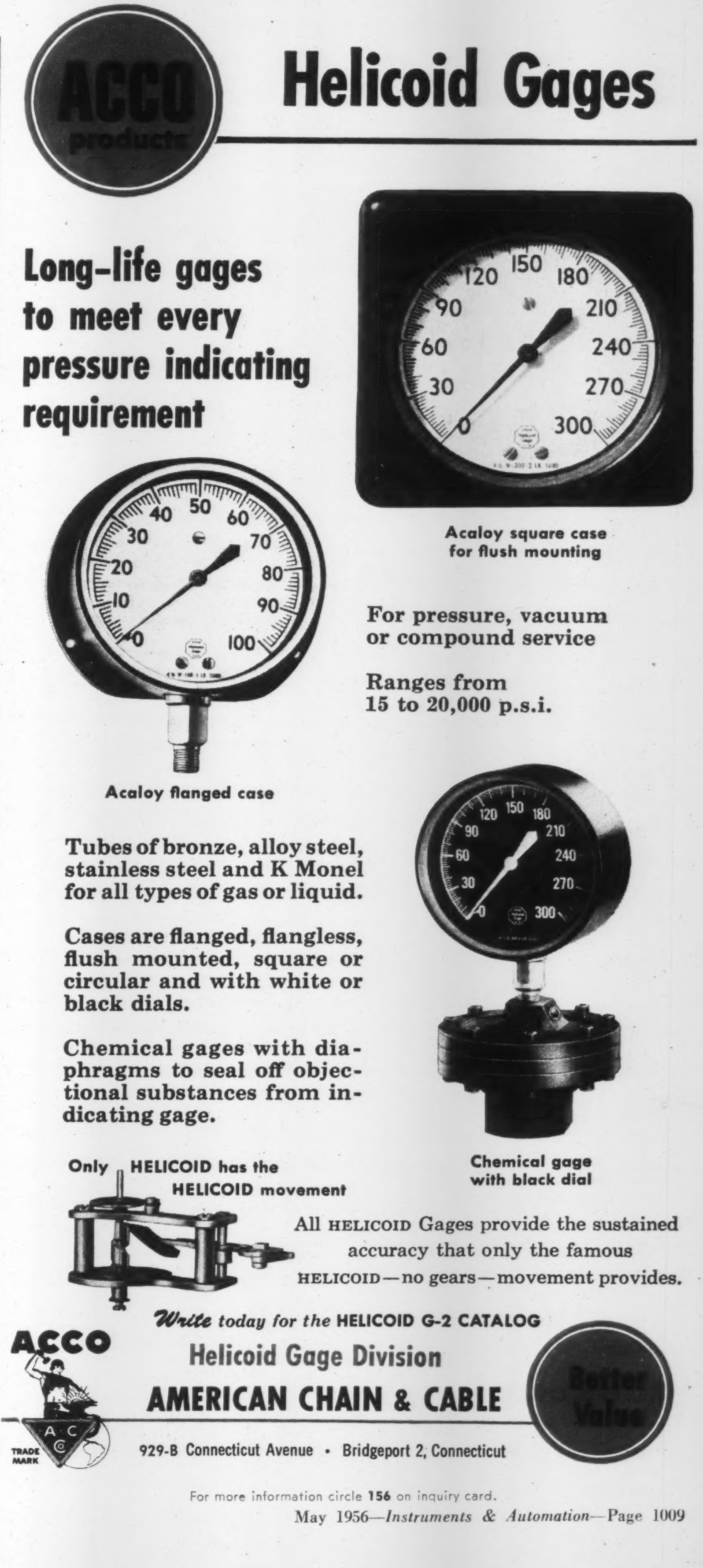
comprising "Super-Flo" which combines a Fibreglas depth filter and a molded drying element. Liquid indicator is "E-Z-See," hermetically sealed to prevent any possible leak in the system. Both are Underwriters Laboratories approved. Receiver is made of steel. New units are available with top inlet-bottom outlet or bottom inlet-top outlet connections.—*Remco, Inc., Zelienople, Pa.*

For more information circle **523** on inquiry card.

OPTICAL GENERATION TECHNIQUE

New technique is said to enable marking dial graduations with "accuracy never before possible in any scientific apparatus." Through optical generation, lines can be exposed on photographic glass plates in a rotat-





ACCO products

Helicoid Gages

Long-life gages to meet every pressure indicating requirement

Acaloy square case for flush mounting

Acaloy flanged case

For pressure, vacuum or compound service

Ranges from 15 to 20,000 p.s.i.

Tubes of bronze, alloy steel, stainless steel and K Monel for all types of gas or liquid.

Cases are flanged, flangless, flush mounted, square or circular and with white or black dials.

Chemical gages with diaphragms to seal off objectional substances from indicating gage.

Chemical gage with black dial

Only HELICOID has the HELICOID movement

All HELICOID Gages provide the sustained accuracy that only the famous HELICOID—no gears—movement provides.

Write today for the HELICOID G-2 CATALOG

ACCO

Helicoid Gage Division

AMERICAN CHAIN & CABLE

Better Value

TRADE MARK

929-B Connecticut Avenue • Bridgeport 2, Connecticut

For more information circle 156 on inquiry card.

BALL and SOCKET DESIGN
Designed by
The Master Designer
Genesis 1:31*
INFINITELY STRONGER

DAHL "DEMI"® TOGGLE ACTUATED VALVE

*Giving credit where credit is due, we offer the "Ball and Socket" principle in our toggle actuated two-way and three-way "DEMI" valves.

The two-way "DEMI" valves are PACKLESS. The three-way "DEMI" Valves are available in the packless design with all three ports piped or with one port vented to the atmosphere. Bodies are stocked in brass, anodized aluminum, steel and stainless steel. The internal parts can be supplied in materials for corrosive or non-corrosive service for pressures to 200 psi. The toggle itself is case hardened steel and cadmium plated and defies rough treatment.

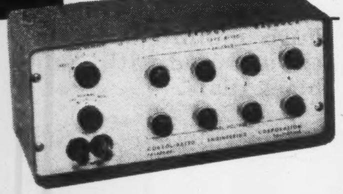
Write for Complete Catalog and Name of our Representative in your area.

GEORGE W. DAHL CO. INC.
BRISTOL • RHODE ISLAND

For more information circle **157** on inquiry card.

Type 8-110
FOUR-CHANNEL
BRIDGE BALANCE

big in usefulness
small in cost
. . . only $375



This general-purpose, four-channel control center brings new accuracy, new convenience to strain gages and resistive-bridge-type pickups. It's small, highly simplified, and rugged . . . usable anywhere for coupling transducers to direct-writing oscillographs, chart recorders, analog-to-digital converters, and other recording or indicating devices. With high-sensitivity galvanometers in a multi-channel photographic recording oscillograph, the 8-110 Bridge Balance permits direct recording without amplifiers. Every laboratory and engineering department engaged in static or dynamic testing will immediately find dozens of uses for this high-performance, low-cost instrument. Send for Bulletin CEC 1560-X16.

Features:

FOUR CHANNELS . . . accommodates 120- to 350-ohm strain gages or pickups—1, 2 or 4 active arms.

VOLTAGE ADJUSTMENT . . . excitation adjustable from 0 to full input voltage for each channel.

BALANCE . . . continuous control on each channel to compensate for initial resistive unbalance.

POWER . . . input voltage, 20v a-c or d-c (max.).

CALIBRATION . . . receptacles for quick plug-in of calibration resistors of any value.

CONNECTORS . . . five-way binding posts for input; standard Cannon plugs for output. Output also available on binding posts.

Consolidated Electrodynamics
CORPORATION
formerly Consolidated Engineering Corporation
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena, California

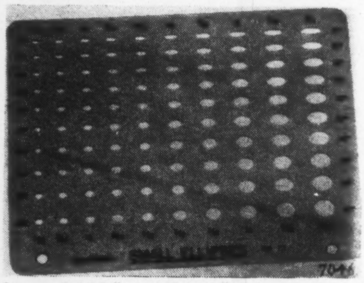
For more information circle **158** on inquiry card.

ing camera. Each line is exposed over 200 times through the same optical system: averaging effect eliminates possibility of error and produces "absolute uniform accuracy as regards line width and spacing, length and their arrangement whether uniform, logarithmic or in accordance with special spacing requirements." This is said to be the only method by which fractional lines, and prime or non-prime numbers in any frequency, can be produced. Complex waveforms, digital computer coding discs and sine wave frequency standards can also be produced.—*Precision Photomechanical Corp.*, 170-51 *So. Van Brunt St. Englewood, N. J.*

For more information circle **524** on inquiry card

ELLIPSES TEMPLATE

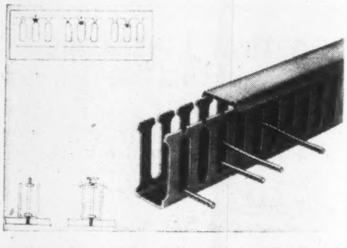
New "No. 73 Small Ellipses Template" groups 100 ellipses in 10 projections from 15° to 60°, in 10 sizes from 3/32" to 5/16"; is made of 0.020" amber-colored mathematical quality plastic. Size 6" x 4-3/4".—*Rapidesign, Inc., Box* 592, *Glendale, Calif.*



For more information circle **525** on inquiry card.

CONTROL PANEL CONDUIT

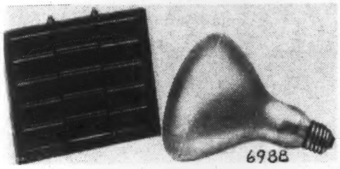
New "Panduit" featuring an exclusive slot design which minimizes wiring time is available in a wide range of sizes from 1" x 1" x 5' to 3" 3" x 5. New slot design simplifies inserting and removing wires; permits attachment of lugs before wire is inserted; allows wire to be removed with lugs attached. "Panduit Fastener" holds both duct and cover and prevents either from slipping; is an internal nut and bolt arrangement without external projections or need of space adjacent to duct; eliminates threading of wires under fasteners.—*Panduit Co., Dept. IAP*, 10132 *S. Washtenaw Ave., Chicago* 43, *Ill.*



For more information circle **526** on inquiry card

SOLAR BATTERY

New improved model of maker's selenium "Sun Battery" is especially designed as a power supply for tran-

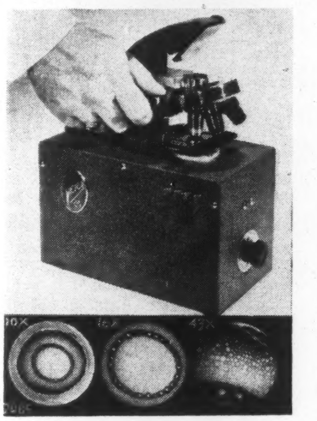


sistorized devices such as portable radio receivers and transmitters. "Sun Batteries" can also be used in conjunction with miniature storage batteries to supply continuous power to a load. Available in production quantities; are said to "offer the greatest economy in milliwatts per dollar of any type of photovoltaic energy converter now available." Each battery comprises a number of selenium photosensitive elements connected in series and, when exposed to very bright incident sunlight (about 10,000 footcandles), delivers maximum output power of 5 mw per active square inch at an output voltage of 0.26 per sensitive element. Battery shown has 1 photoelements connected in series: output voltage about 4 v at max power transfer operation, and 8 v open-circuit.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **527** on inquiry card.

MICRO SLIDE PROJECTOR

New "Magnascope V200T" microscope-slide projector incorporates three objectives: 10X, 16X and 43X.



When projecting on a movie screen, image size is controlled by the distance. Variable light focus allows adjusting 200-watt lamp for maximum brilliance with any objective. Matched lenses for light-condensing system give highest-intensity light and enable high-power objective lenses to perform at greatest efficiency. Front-surface mirrors further sharpen image, transmit more light and truer color, and completely eliminate refraction distortion.—*Victor Animatograph Corp, Davenport, Iowa.*

For more information circle **528** on inquiry card.

New!

IDEAL SURVEY METER FOR RADIATION SAFETY

- **Compact, convenient, accurate**
- **Operates on a single flashlight cell**
- **Weighs only 2 pounds**
- **Beta or gamma by twist of a knob**
- **Two ranges: 0-25 mr/hr, 0-1 r/hr**
- **Accessories to multiply or divide both ranges by 10**

Curtiss-Wright

RADIAMETER

The Curtiss-Wright Radiameter is a radiation survey meter designed especially for health physics and industrial hygiene applications. Using a unique inverted triode circuit, it performs functions usually requiring two instruments. The lower scale provides high sensitivity for decontamination monitoring. The high scale measures stronger radiation fields usually requiring an ionization chamber type instrument.

Where other radiation survey meters require several expensive and hard-to-find batteries, the Radiameter is powered by a single inexpensive flashlight cell. It is easy to handle and slips readily into a suit coat pocket.

Having the appearance of a light meter or camera, it attracts minimum attention from plant personnel during safety checks. The one-piece cast aluminum case is light in weight, but extremely rugged and waterproof. The Geiger tube or battery may be changed in seconds and without tools. Controls are simple, even for non-technical personnel, and the meter is easy to read.

Accuracy is ±10% of full scale on both scales for energies from 50 to 1,200 kev. The Radiameter is useful for monitoring energies as low as 15 kev. In the presence of radiation of high intensity, the instrument does not overload but continues to read off-scale. It can be zeroed even in a strong field. Its fast response permits monitoring x-ray installations turned on only momentarily. Battery life is long—approximately 140 hours.

Available accessories include a probe to multiply sensitivity by 10, a tube to divide sensitivity by 10, an alpha tube, a radium calibration source, a push-button on-off switch, and an attractive leather carrying case. Write for details.

Component and Instrument Sales Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

For more information circle **159** on inquiry card.

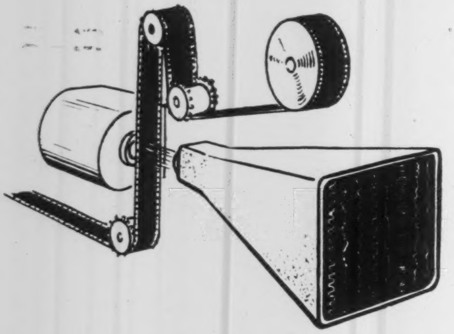
mr/h
r/h
CURTISS-WRIGHT

INSTRUMENTS and AUTOMATION Briefs

For this literature circle number on inquiry card.

1000-cps Direct-Writing Oscillographic Recorder

The Acton Laboratories Recorder, Type 550-A, is an 8-channel, high-frequency, direct-reading oscillograph. It has eight separate galvanometers and styli, plus a reference marker stylus, which scribe transparent waveforms on 35-mm acetate film that is coated with carbon. A plastic spray fixes the image to provide a compact permanent record having the appearance of a photographic negative. As the waveforms are being scribed, the light is projected through the film, and the image magnified 5 times on a ground-glass viewing screen. Test results can thus be seen instantaneously.



The galvanometers used in the Acton 550-A may be directly driven by signals in the frequency range from DC to 1000 cps for timing applications where waveform distortion is unimportant, or by signals not exceeding 300 cps if frequency response is critical. (*From new 8-page brochure "The Acton 550-A", Acton Laboratories, Inc., Acton, Mass.*)

For this literature circle **601** on inquiry card.

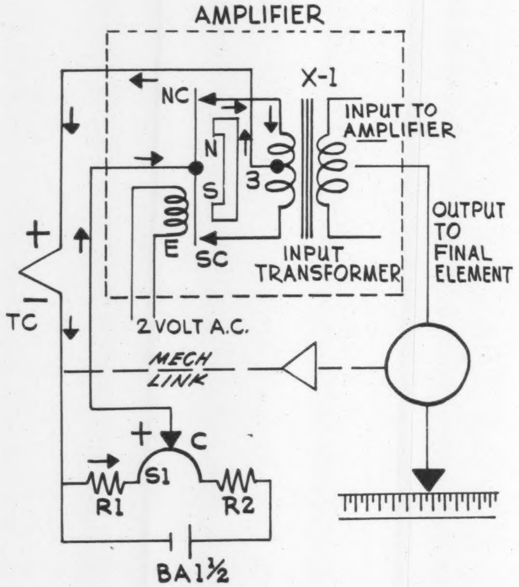
Accidental Scientific Discoveries

The essential truth of Pasteur's statement "In fields of observation chance favors only minds that are prepared," is aptly revealed in the stories of 21 discoveries told in this booklet . . . Nobel cut his finger and covered it with collodion. Blasting gelatin resulted from that accident. Hyatt also cut his finger but couldn't put collodion on it because the bottle was empty. Its contents had spilled onto the shelf of his medicine cabinet where it had hardened. The result this time was celluloid, the first synthetic plastic. Hilaire de Chardonnet also accidentally spilled a bottle of collodion. This accident was the forerunner of rayon, the first synthetic fabric. (*From new 64-page booklet "Accidental Scientific Discoveries," Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.*)

For this literature circle **602** on inquiry card.

Microconverter Chopper

The Microconverter or "chopper" used in the new 800 Series is a modified Micropositioner. It is used to conver the measured DC signal to AC for the purpose of amplification. The unit adheres to rigid Air Force specifications.



It has been under a two-year life test of over three million cycles at 26 volts high load, 60 cycles per second at 0.1 amperes. In the actual 8000 Series application, the Microconverter will operate on 2 volts AC with only 1 millivolt signal.

The unit is a single-pole, double-throw switch operated by a metal reed. Because of a permanent magnet, the reed vibrates in response to the magnetic field causing the Microconverter contacts to be operated in synchronism with the 60 cycle line. Coil E is the energizing coil.

A phase shifting capacitor is in series with R-13 to provide correct phase relationship and keep the voltage constant. (*From new 4-page Educational Release No. 12, Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.*)

For this literature circle **603** on inquiry card.

Amplistats

General Electric amplistats, which are self-saturating magnetic amplifiers, have been developed for efficient application to a wide range of control and instrumentation systems. They are capable of "sensing" small signal changes, amplifying them greatly, and imparting the amplified signals to the system to accomplish the desired control. Units have been built from fractional volt-amper

Circle **160** on inquiry card. →

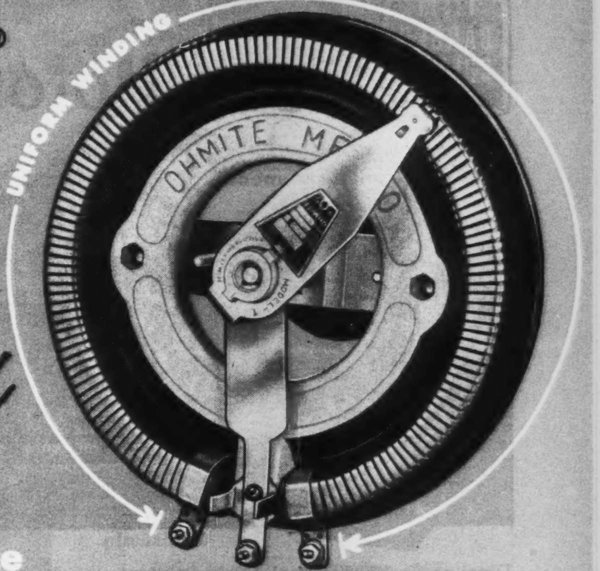
OHMITE®

taper-wound

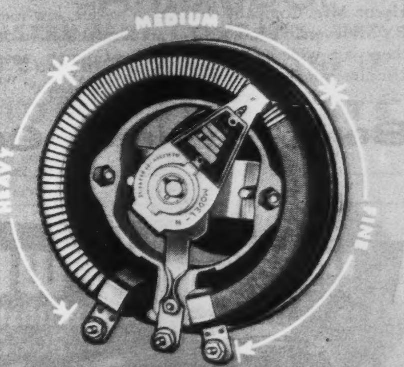
RHEOSTATS

reduce rheostat size required

Tapering the wire size to match the current carried permits greater capacity in a smaller unit!



LINEAR-WOUND



EQUIVALENT TAPER-WOUND

A smaller rheostat may often be used for a given load by having the rheostat windings tapered or wound in two or more sections of diminishing wire sizes. This can be done because only the first turn of the winding carries the maximum current . . . succeeding turns carry reduced amounts. This makes possible great savings in control-panel space, making Ohmite taper-wound rheostats particularly useful in portable equipment. Ohmite taper-wound rheostats are also very durable because they use the largest wire sizes practical for the current to be carried.

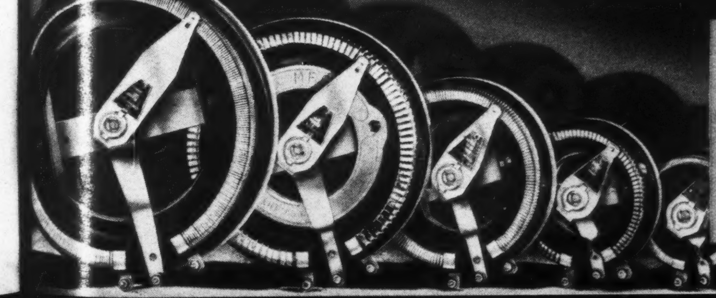
MORE UNIFORM CONTROL—For a given application, the tapered winding also provides more uniform control. Because a linear-wound rheostat adds a constant number of ohms per degree of rotation to a constantly increasing number of ohms, the current changes more slowly as the resistance is increased. A tapered winding, by increasing the number of ohms per degree of rotation as the total ohms in circuit increases, makes the current curve more nearly linear.

Ohmite has an extensive line of standard tapered rheostats, or will design special tapered windings to suit individual needs.

Write on company letterhead for Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING COMPANY, 3615 Howard Street, Skokie, Illinois (Suburb of Chicago)

MORE OHMITE RHEOSTATS SOLD THAN ALL OTHER MAKES COMBINED



Be Right with

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

BARBER COLMAN **Small Motors**

chosen to drive counters in new Hycon instruments

Barber-Colman BYAE reversible motor designed for control by electronic circuits.

Direct reading, 3-digit display gives quick, accurate data for users of the new Hycon digital voltmeter, shown above, and its companion instrument, the Hycon digital ratiometer. To drive these counters, Hycon Mfg. Company chose high-torque, low-inertia Barber-Colman BYAE reversible motors. For accurate actuation of your products, too, there is a wide selection of Barber-Colman motors up to 1/20 hp. Unidirectional, synchronous, and reversible . . . with or without gearing . . . open or enclosed. Write for new Catalog F-4271-6.

Barber-Colman Company

Dept. E, 1215 Rock Street, Rockford, Illinois

For more information circle **161** on inquiry card.

INSULATED WIRE that will withstand 2000°F

Will last forever in service—eliminating costly replacement

- Available in outside diameters of .04 to .32.
- One or more wires insulated with a pure mineral swaged into a metal tube.
- Can be sharply bent.
- Sheath can be welded without loss of insulation.
- Available in a variety of sheath metals with thermocouples and other wire materials.
- Complete thermocouple probes available using this material made to your requirements.

Write for Bulletin 4

Aero Research
INSTRUMENT COMPANY, INC.
315 NO. ABERDEEN STREET, CHICAGO 7, ILLINOIS
Sales Representatives throughout the United States and Canada

For more information circle **162** on inquiry card.

BRIEFS—CONTINUED

to 10,000 volt-ampere sizes, and can be built even large.

The following are a few of the many possible combinations of signal sources and controlled devices:

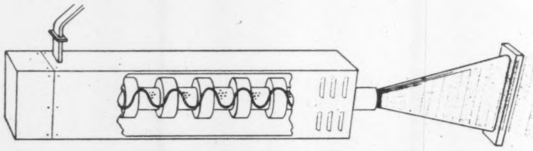
Signal sources	**Controlled devices**
Thermocouples	Relays
Strain gages	Solenoids
Thermistors	Small motor fields
Phototube amplifiers	Generators
Transistor amplifiers	Amplidyne fields

(*From new* 40-*page Catalog GEC*-1016, "*Measurin Equipment for Laboratory and Production Testing, i- cluding Radiation Instruments,*" *General Electric C, Schenectady* 5, *N. Y.*)

For this literature circle **604** on inquiry card.

Electron-beam Processing

Particle accelerators (or "atom-smashers"), long use as sources of intense radiation in nuclear physics researc and in medical therapy, are now generally recognized a the principal sources of radiation for industrial use . . . (1) preservation of foods, (2) sterilization of drugs, (3 cross-linking of plastics, (4) initiation of chemical rea- tions.



KESTER SOLDERFORMS®

BIG STEP in

Production Cost-Cutting!

Take a giant step forward in lowering assembly costs with Kester Solderforms. Labor costs are reduced, assembly operations speeded up. There's no solder waste, and the end result is a neater, more expertly finished product.

WRITE TODAY for complete Kester Solderforms information. Free!

KESTER SOLDER COMPANY
4270 Wrightwood Ave.
Chicago 39, Illinois
Newark 5, New Jersey
Brantford, Canada

For more information circle **163** on inquiry card.

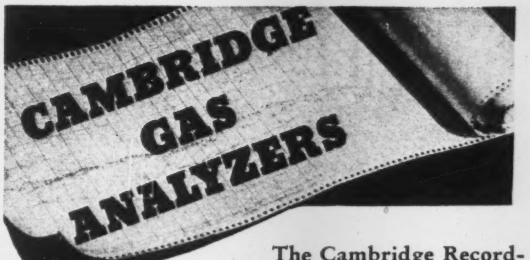
Roentgen	1esu/cm^3 air NTP	$Megarep_{83}$	8.38 watt-sec/gm 3.8 KW-sec/pound
Rep_{83}*	83.8 ergs/gm	Megarad	10 watt-sec/gm 4.54 KW-sec/pound
Rep_{93}	93 ergs/gm	1 watt	70 curies Co^{60} 240 curies Cs^{137}
Rad	100 ergs/gm		
Erg	10^{-7} watt-seconds		

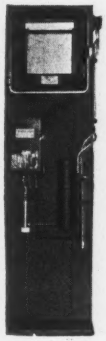
Model	Volts (MV)	Average current (Ma)	Average power (KW)	Total penetration of beam cm H_2O	Penetrative at 60% level◆ cm H_2O	Processing capacity (#/hr/Megarep)	Approximate cost●
JS	1	0.25	0.25	0.50	0.33	240	$ 35,200*
AK-S	2	0.25	0.50	1.00	0.66	480	63,800*
KS	3	1.00	3.00	1.50	1.00	2880	114,000*
D-5	5▲	0.75	3.75	2.50	1.65	3600	169,000
D-10	10▲	0.35	3.50	5.00	3.33	3360	195,000

◆ The so-called 60% ionization level is that depth at which the dosage level equals that on the top surface. It is approximately ⅔ of the total range of the electrons.

When high-velocity electrons collide with matter, the chemical changes brought about are essentially the same as those induced by x-ray or beta or gamma radiation . . . The great advantage of the electron beam is the very high intensity that can be produced.

High Voltage now offers two different types of particle accelerators for processing—the Van de Graaffs for energies between 1 and 3 million volts, and the microwave linear accelerators for use in the energy range between 3 and 15 million volts. The two types are radically different in operating principles . . . the Van de Graaf develops its accelerating voltage by carrying electric charge to an insulated high-voltage terminal by means of a rapidly mov-





The Cambridge Recording Gas Analyzer continuously analyzes and records as many as six constituents of a gas. Eliminates intermittent, slow and expensive manual gas analysis. Accurate . . . Sensitive . . . Simple. No moving parts; utilizes thermal conductivity principle.

Makes possible substantial savings in the operation of kilns, production of inert gases, and in metallurgical, petroleum, and other chemical processes. Single- and Multi-point instruments are available for a wide variety of applications.

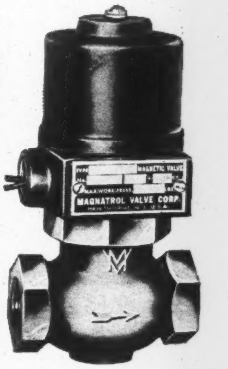
Send for literature mentioning application

CAMBRIDGE
INSTRUMENT COMPANY, INC.
3526 Grand Central Terminal, New York 17
Pioneer Manufacturers of
PRECISION INSTRUMENTS

For more information circle **165** on inquiry card.

Eliminate

Costly Flow Failures



Magnatrol
SOLENOID VALVES

Quick Operating *Non Sticking* *Tight Seating*

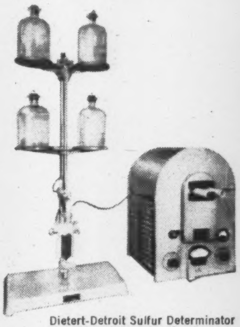
These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves.** Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. **Every Magnatrol Valve** is delivered to you—factory **tested—guaranteed** free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

Catalog containing complete specifications mailed upon request.

Magnatrol
VALVE Corp.
HAWTHORNE 14
NEW JERSEY

For more information circle **164** on inquiry card.



Dietert-Detroit Sulfur Determinator No. 3104, with combustion furnace.

FAST, ACCURATE
SULFUR
TESTING

with a
DIETERT-DETROIT
Sulfur Determinator

Test for sulfur the modern easy way with a low cost Dietert-Detroit Sulfur Determinator. It's *fast* . . . much faster than the gravimetric method. It's *simple* . . . direct reading burette—no involved measuring or computing. It's *accurate* . . . correct analysis of sulfur content in scores of materials. Durable, easy-to-clean glassware design.

Fast, accurate *carbon* tests made also with Dietert-Detroit Carbon Determinators.

Ideal for testing these materials and many more!

COAL / COKE / IRON / STEEL
NON-FERROUS METALS
STAINLESS ALLOYS
MINERALS
PETROLEUM PRODUCTS
ORGANIC CHEMICALS
WOOD

Send for free catalog!

Describes the complete line of Dietert-Detroit carbon and sulfur determinators, accessories and supplies.

HARRY W. DIETERT CO. **CONTROL EQUIPMENT**
9330 ROSELAWN **DETROIT 4, MICHIGAN**

Send me your latest Carbon-Sulfur Determinator catalog.

NAME____________________
COMPANY____________________
ADDRESS____________________
CITY____________ STATE________

For more information circle **166** on inquiry card.

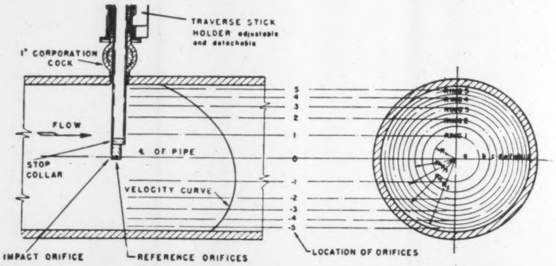
ing belt. The entire accelerating voltage thus developed is directly insulated by gas under pressure and is held constant by balancing the charge carried by the belt agains the electron-beam current drawn from the terminal.

The microwave linear accelerator does not use ver high voltages for accelerating particles. Instead, travelin waves of high frequency microwave (radar) power ar generated and directed down an evacuated waveguide. *(From new 36-page Bulletin E, High Voltage Engineerin Corp., 7 University Rd., Cambridge 38, Mass.)*

For this literature circle **605** on inquiry card.

Pitot Equipment

The object of making the pipe traverse by the use o the Pitot Rod and the manometer is to ascertain the relation between the mean velocity and the center velocity i the pipe. The Pitot Tube measures velocity only at th point in the pipe where the orifices are located. If th orifices of the Pitot Tube be moved along the diameter o the pipe it will be noticed that the velocities are differen



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]

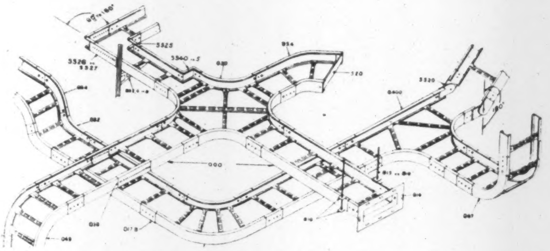
for different locations of the orifices, and that they gradually increase as we approach the center of the pipe. Therefore, to accurately determine the quantity of water flowing it is necessary to know the traverse coefficient—that is, the relation of the mean velocity to the center velocity.

The method to be employed in making the traverse is that of dividing the pipe into imaginary rings or annuli having equal areas, and then taking readings of the deflections of the liquid in the manometer when the orifices of the Pitot Tube are placed at a point in each ring such that a circle through that point will divide the ring into two equal areas. (*From new 20-page bulletin* 1301, *Simplex Valve & Meter Co., Lancaster, Pa.*)

For this literature circle **606** on inquiry card.

Piping Racks

P-W ladder type racks and hangars support power and control cables and instrument air piping . . . Ladders are available in widths of 6, 9, 12, 18, and 24 inches and in radii of 8 and 24 inches. (*From new* 12-*page brochure* 156-*E*, *P-W Industries, Inc., Duncan & Melrose Sts., Phila.* 24, *Pa.*)



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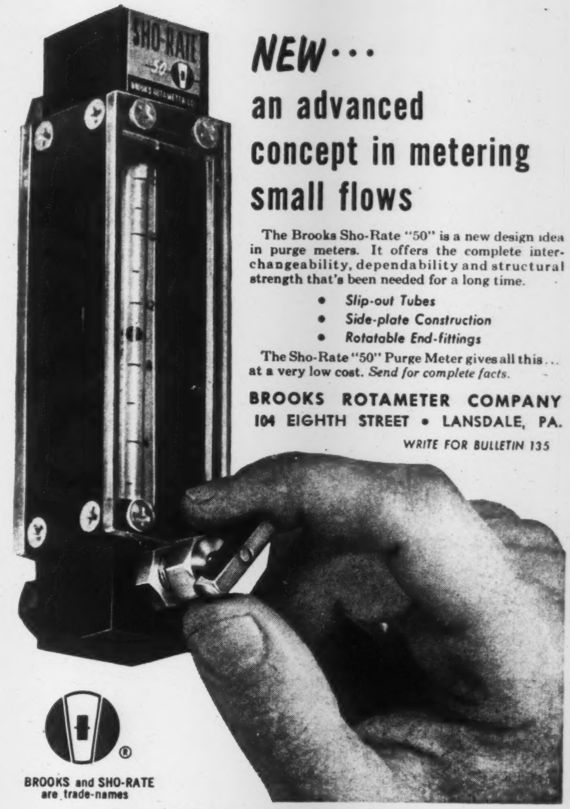

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Temperature Range	One Rotation of Chart
−30° to +120°F	7 Days
−30° to +120°F	24 Hours
−20° to + 40°F	24 Hours
−10° to + 50°F	7 Days
−10° to + 50°F	24 Hours
30° to 60°F	24 Hours
40° to 100°F	7 Days
40° to 100°F	24 Hours
60° to 90°F	24 Hours
60° to 90°F	8 Hours
70° to 130°F	24 Hours
−25° to + 10°C	24 Hours
5° to 40°C	24 Hours

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The TEMPSCRIBE self-registering Recording Thermometer meets a long-felt need for a moderately priced recorder for general purpose applications where a graphic record of temperature in surrounding air is required. The record—written on an easy-to-read chart, 4″ in diameter, with graduations spaced uniformly over full range—is indispensable wherever knowledge is desired if temperature goes above or below any given point. TEMPSCRIBE is the only recorder made with pen and actuating element in door, which, when opened, permits a clear view of the complete chart, and easy chart replacement without danger of damaging pen arm or accidentally marking chart.

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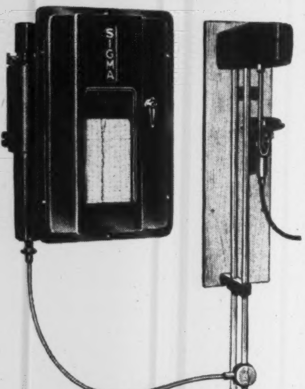

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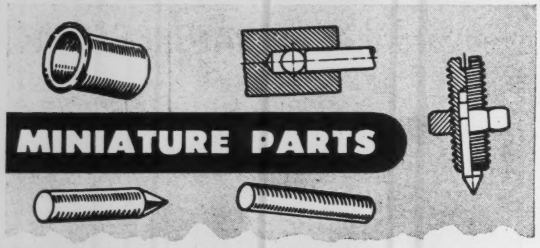

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- "Welton" noncorrosive paste solder for hairsprings or similar soldering.
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The term "Automated Data Processing" means the continuous and integrated operation of data processing using automatic machines . . . The punched codes shown represent a standard teletype code which has been used in wir transmission for many years.

The first important point we must know is the commo language used by the machine. Second, whether the ma

COMMON LANGUAGE INPUT and/or OUTPUT BY MACHINE

X - INPUT
✓ - OUTPUT

MACHINE	PUNCHED PAPER TAPE			PUNCHED TAB CARDS
	5 Channel	6 Channel	8 Channel	
FLEXOWRITER	X ✓	X ✓	X ✓	
IBM CARDATYPE			✓	X ✓
IBM 824				✓
IBM 884			✓	
REM RAND SYNCHROMATIC				✓
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NCR 2000	✓	✓	✓	
BURROUGHS SENSIMATIC	✓	✓	✓	
FRIDEN ADD PUNCH	✓	✓	✓	
MONROE AUTO-PUNCH ADDING MACHINE	✓	✓	✓	
MONROE AUTO-PUNCH BOOKKEEPING MACHINE	✓	✓	✓	✓
A/M GRAPHOTYPE	X	X		
IMR SCANNER				✓
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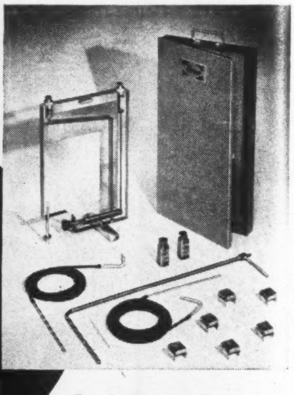
One Instrument Tells Both Air Velocity and Static Pressure!



Reads directly in feet per minute and inches of water.

Check *all* velocities from 400 to 10,000 F.P.M.

All static pressures from 0 to 10" of water.

Tests fan and blower discharge and inlet pressures, pressure drop across filters, balances air conditioning systems, etc. Complete kit includes dual purpose manometer, 18" stainless steel pitot tube, Magneclips and all necessary fittings, tubings, instructions and accessories.

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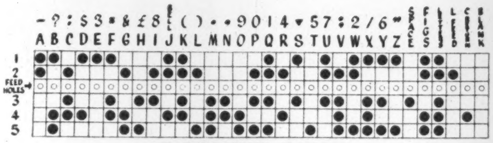
- ? : $ 3 • & £ 8 BELL ( ) . . 9 0 1 4 • 5 7 ; 2 / 6 "
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z SPACE FIGS LTRS LFEED CRETN BLANK
1
2
FEED HOLES
3
4
5

5 CHANNEL TAPE

58 Codes - 26 letters - 26 figures - 6 Machine Functions

6 CHANNEL TAPE

Basically same as 5 Channel plus upper and lower case letters

7 CHANNEL TAPE

Basically same as 6 Channel plus check Channel

8 CHANNEL TAPE

Basically same as 7 Channel plus field designation channel

hine uses the common language as input, output or both. he chart gives this information. (*From new 124-page ook MI-118, "Automated Data Processing," Moore Busi- ess Forms, Inc., Niagara Falls, N. Y., which covers all ypes of commercially available data-processing machines.*)

For this literature circle **608** on inquiry card.

N-M-R Spectroscopy

The "resolving power" of a High Resolution N-M-R Nuclear Magnetic Resonance) Spectrometer is determined by three basic factors: (1) the field uniformity of the applied d.c. magnetic field over the sample dimensions, 2) the time stability of the applied d.c. magnetic field, and finally, (3) the time stability of the applied radio transmitter frequency. It was recognized that the third requirement could be met rather directly by using r-f techniques involving crystal-controlled oscillators, but the first and second requirements have been the subject of painstaking investigation since the early days of the High Resolution form of N-M-R Spectroscopy. (*From new 4-page folder INS-1203, Varian Associates, 611 Hanson Way, Palo Alto, Calif.*)

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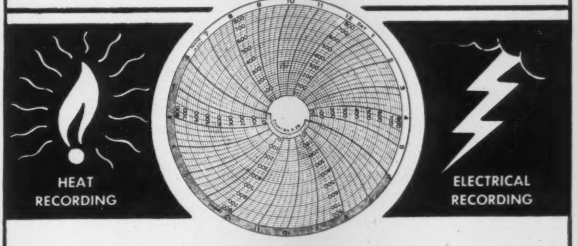
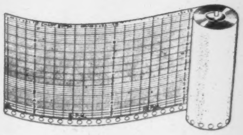
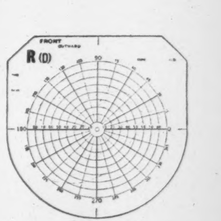
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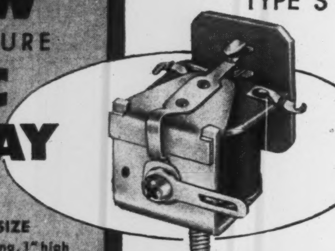

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BRIEFS—CONTINUED

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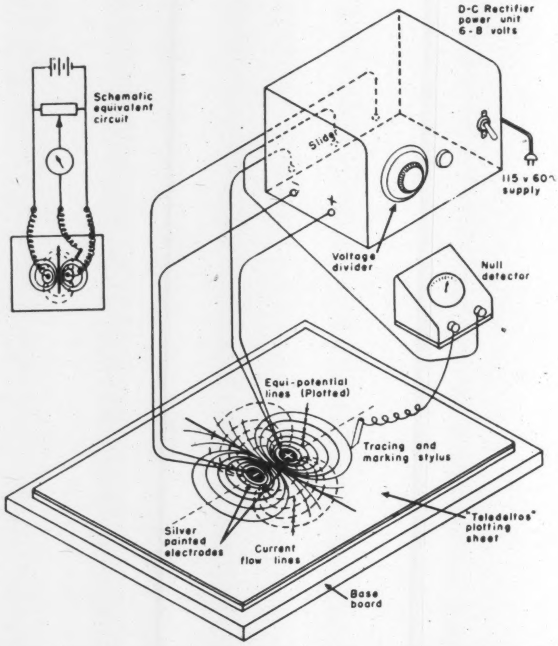
The Analog Field Plotter consists of a thin sheet of commercially available electrical conducting paper (Type L Teledeltos 0.004-in. thick) in which an electrical current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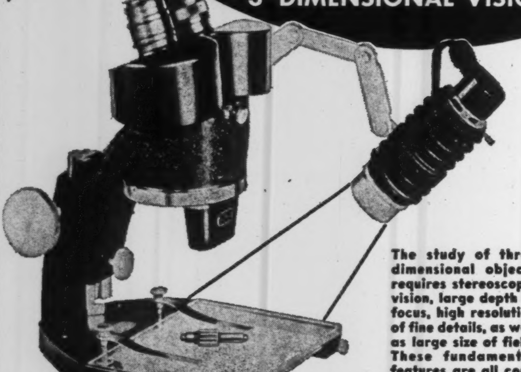

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For more information circle **180** on inquiry card.

flow pattern is set up by means of suitably attached and energized electrodes. The resultant potential-drop pattern established by this current pattern is detected and marked (i.e. plotted) directly on the paper by means of a searching stylus in conjunction with a high-sensitivity detecting instrument.

Table 1 covers the five most commonly encountered types of fields:

No.	Type of Field	Flux Functions	Potential Function
1	Electrostatic	Dielectric Flux	Electrostatic Potential
2	Magnetostatic	Magnetic Flux	Magnetostatic Potential
3	Electric Current	Electric Current	Electric Potential
4	Temp. (stationary)	Heat Power Flow	Temperature
5	Fluid (dynamic)	Flow Rate	Velocity Potential

(*From new 50-page Instrumentation Manual IM24, "Use and Theory of the Analog Field Plotter," Sunshine Scientific Instrument,* 1810 *Grant Ave., Phila.* 15, *Pa.*)

For this literature circle **610** on inquiry card.

Analog Computer

The Weber general purpose analog computer is a low-cost computer complete within one basic unit . . . . The computer provides both real time and fast time. In fast time, the speed of the problem is accelerated 50 times faster than real time. The solution can be repeated automatically to permit the operator to monitor the change in varied conditions until the proper solution is present. By using fast time, a large group of responses can be noted in a very short time.

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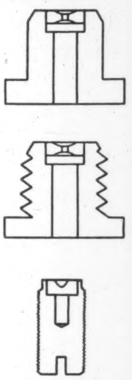

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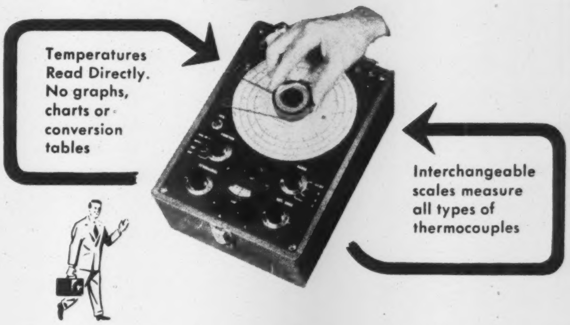
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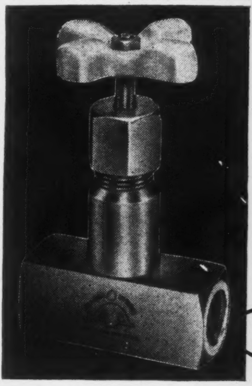
For more information circle **182** on inquiry card.



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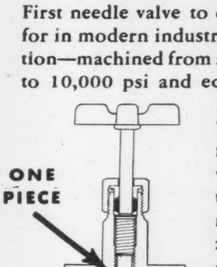
MAXIMUM WORKING PRESSURE 10,000 PSI

. . . for finer regulation of water, oil or gas

First needle valve to combine all the characteristics called for in modern industry. Embodies sturdiest basic construction—machined from solid bar stock—suitable for pressures to 10,000 psi and equally efficient in lower range. Note stem guide fused to body by new "Conoweld" process, eliminating faults of conventional two-piece valves. Stem 416 stainless steel. Stem threads fine pitch for strength and micrometer regulation. Body electro-zinc plated. Sizes ⅛" to 1", globe and angle patterns.



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Pioneers in pneumatic timing.

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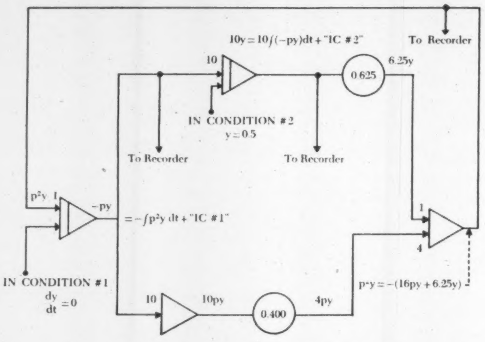
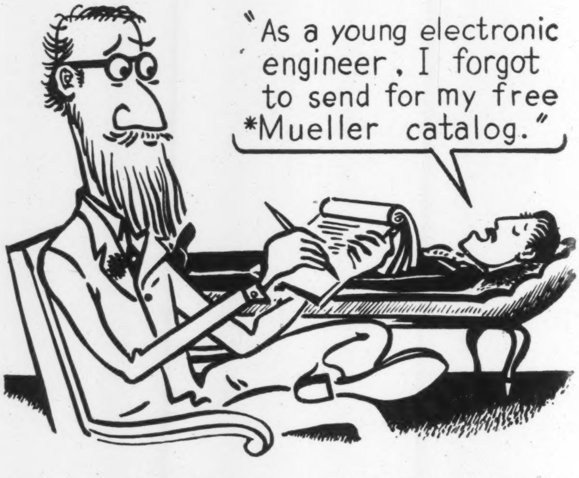


ting 816 or 1632 connections; 1 Readout system consisting of a six-inch Meter with mirrored scale; a five-inch Dual Beam Cathode Ray Oscillograph; 4 Push-button type controls for setting Computer, Hold, Initial Condition (IC) and Pot Set. Illustration shows typical problem setup. (*From new 6-page folder, Weber Aircraft Corp., 2820 Ontario St., Burbank, Calif.*)

For this literature circle **611** on inquiry card.

Vidigage

The Branson Vidigage is an ultrasonic gage for production testing with laboratory accuracy and versatility. It measures a wide range of thickness, detects laminar discontinuities and internal defects, and is easily operated by nontechnical personnel. All operations are carried on non-destructively, from one side of the work. Indications are read from a bright vertical line on a 21-inch cathode-ray screen with interchangeable scales and large scale numbers, with excellent visibility at distances up to 20 feet under normal shop-lighting conditions.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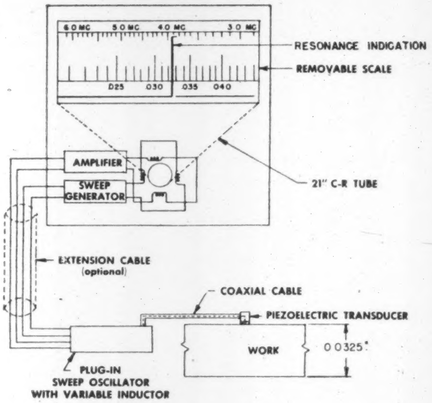

Scales for steel are usable with stainless steel, nickel, monel, inconel, and similar alloys. Direct-reading scales for aluminum, brass, copper, cast iron, lead, glass, plastics, and other good conductors of sound, are also available. Probes with flat transducers are usually suitable for convex curvatures down to 2" OD; ground curved transducers are supplied from smaller convex curvatures, and for concave surfaces.

A vibrating piezoelectric transducer, applied to one surface of the material under test, transmits continuous ultrasonic waves into the material through a thin liquid layer. An electronic sweep oscillator excites the transducer, and causes it to vibrate over a range of frequencies generated by the oscillator. A series of plug-in oscillators is used to generate any desired frequency between 0.7 and 20 Mc. (*From new 4-page brochure V-101, Branson Instruments, Inc., 430 Fairfield Ave., Stamford, Conn.*)

For this literature circle **612** on inquiry card.

E-3035

BROOKS DEFLECTION POTENTIOMETER

FOR RAPID AND ACCURATE CALIBRATION OF D.C. AMMETERS, VOLTMETERS, WATTMETERS

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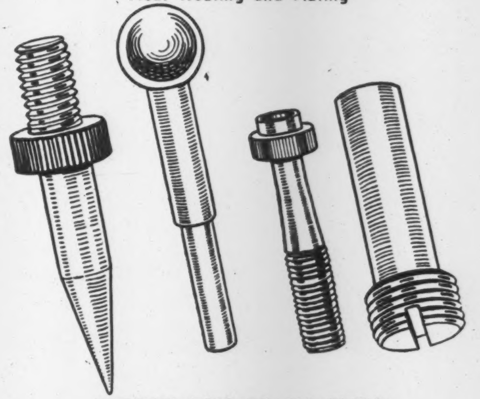
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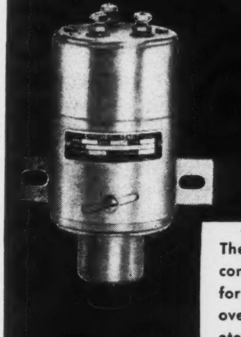
MODEL GH-2

The Synchro-Start Model GH-2 governor contains two snap action switches to be used for opening or closing circuits at any RPM over 500 and is for standard SAE tachometer cable drives. They contain sealed ball bearings, are adjustable while running, and are encased in a splash proof housing. These two switch governors are also supplied for a standard distributor take-off and for AND20005 engine pad mounting (GA Series).

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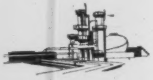
INSTRUMENTS and AUTOMATION New Literature

AUTOMATION



Recorder, Controller. New 64-page Bulletin P1245A describes and illustrates maker's "Dynamaster" electronic potentiometer and bridge instruments for recording and controlling. Covers details of instrument in components, lists sensing elements and special attachments and presents other equipment of maker in which "Dynamasters" have been incorporated.—The Bristol Co., Waterbury 20, Conn.

Circle **613** on inquiry card.

Tank Switching Control. New 8-page Bulletin CP-3030 presents maker's automatic tank switching controls; also introduces new pneumatic level controller plus conventional electrical and electronic remote tank gaging systems.—The Vapor Recovery Systems Co., 2820 N. Alameda St., Compton, Calif.

Circle **614** on inquiry card.

Chlorine Gas Control. New 4-page Bulletin 840-J8A describes maker's "Chlorinizer" that controls and meters chlorine gas under vacuum to produce and deliver chlorine-water solution to point of application.—Builders-Providence, Inc., Providence 1, Rhode Island.

Circle **615** on inquiry card.

Feedwater Controller. New 4-page Bulletin 5623 pictures and describes maker's water level remote control based on expansion of Harb tubing assembly.—The C. E. Squires Co., 18502 Syracuse Ave., Cleveland 10, Ohio.

Circle **616** on inquiry card.

Contact Meter-Relays. New 40-page Catalog 4A presents principles, circuitry, operation, and application of large line of temperature and process controllers based on contact-type meter relays.—Assembly Products, Inc., Chesterland 1, Ohio.

Circle **617** on inquiry card.

VALVES

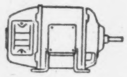
Solenoid Valves. New 6-page Bulletin SK356 describes maker's line of "Speed King" pilot-operated solenoid valves.—Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

Circle **618** on inquiry card.

Air Valves, Nozzles. New 4-page Bulletin 587 presents large line of air valves, nozzles, cocks, safety valves, etc. Also data on cost of air leaks.—Lunkenheimer Co., Cincinnati 14, Ohio.

Circle **619** on inquiry card.

MOTORS, SERVOS



Motor Control Center. New 24-page Brochure GEA-6367 describes maker's "Type DA7093" general-purpose motor control center for centralized control of a-c motors.—Distribution Assemblies Dept., General Electric Co., Plainville, Conn.

Circle **620** on inquiry card.

Instrument Motors. New 36-page Catalog C235610M presents data on maker's motors—axial flow blowers, hysteresis synchronous, control, damped control, gearhead and special purpose. Also principles of motor selection.—Servomechanisms, Inc., Mechatrol Div., 625 Main St., Westbury, N. Y.

Circle **621** on inquiry card.

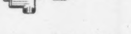
Synchros. New 4-page Bulletin 376 presents specifications of over 138 synchros, servo motors and resolvers.—Precision Components Div., Norden-Ketay Corp., 555 Broadway, New York 12, N. Y.

Circle **622** on inquiry card.

Speed Control. New 28-page Catalog 65 describes maker's mechanical power transmitting unit for providing variable speeds.—Lewellen Mfg. Co., Columbus, Ind.

Circle **623** on inquiry card.

TEMPERATURE



Thermistors. New 4-page Booklet TH-15 presents basic principles and applications of thermistors for measuring or controlling temperatures.—General Electric Co., Carboloy Dept., Detroit 32, Mich.

Circle **624** on inquiry card.

Heaters. New 60-page Bulletin GEC-1005G presents application index, calculating data, specs and prices on maker's standard heaters and heating devices, including immersion, strip, cartridge, tubular, fin, switch and unit heaters; melting pots, soldering irons, oven equipment and controls.—General Electric Co., Schenectady 5, N. Y.

Circle **625** on inquiry card.

Induction Heaters. New 8-page Bulletin GEA-6388 presents specs, dimensions, operating information, design features and ratings of maker's new line of electronic induction heaters.—General Electric Co., Schenectady 5, N. Y.

Circle **626** on inquiry card.

Heating Elements. New 8-page Catalog 102 presents maker's line of silicone rubber, neoprene strip and blanket-type electric heating elements, including custom-designed elements.—Electro-Flex Heat Inc., 516 Asylum St., Hartford 5, Conn.

Circle **627** on inquiry card.

Temperature Conversion, Engineering Chart. New wall chart includes tables on temperature conversion, wire sizes for motor circuits, etc.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle **628** on inquiry card.

Temperature, Speed, Radiation Measurement. New 40-page Catalog GEC-1016 presents maker's temperature, speed, radiation, color, and magnetic-field measurement equipment. Also covers circuit testing, oscillographs, timing devices, x-ray diffraction equipment, etc.—General Electric C., Schenectady 5, N. Y.

Circle **629** on inquiry card.

Thermo-Regulators. New 2-page Bulletin 649 describes maker's "Merc-to-Merc" thermo-regulators based on contact between mercury columns.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **630** on inquiry card.

PRESSURE

Vacuum Gage. New 2-page bulletin describes new "Model 520" Alphatron ionization vacuum gage ruggedized to the point where exposure to atmospheric pressure will not harm it.—NRC Equipment Corp., 160 Charlemont St., Newton Highlands 61, Mass.

Circle **631** on inquiry card.

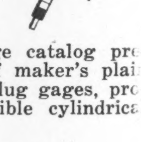
Pressure Switch. New 2-page bulletin describes and illustrates maker's "Series 600 Bondee" pressure-sensitive pressure switch.—Alloy Bellows Engineering Co., 18125 Roseland Rd., Cleveland 12, Ohio.

Circle **632** on inquiry card.

Air-Pressure Regulator. New 4-page Bulletin DB-1155 describes and illustrates maker's "Model 101" manually-controlled air-pressure regulator.—Accessory Products Corp., 616 W. Whittier Blvd., Whittier, Calif.

Circle **633** on inquiry card.

GAGING



Gages. New 52-page catalog presents complete list of maker's plain cylindrical ring and plug gages, progressive and reversible cylindrical plug, plain tapered plug and ring gages, master setting discs, etc.—Dearborn Gage Co., 22038 Beech St., Dearborn, Mich.

Circle **634** on inquiry card.

Gaging Systems. New 28-page Catalog 56 AM presents line of precision instruments for controlling linear dimensions. Includes electric, electronic, pneumatic, and combination systems. —Federal Products Corp., 1144 Eddy St., Providence 1, R. I.

Circle **635** on inquiry card.

Granite Surface Plates. New 4-page folder presents maker's black (diabase) granite for surface plates.—Lawley Granite Surface Plate Co., 2000 Wyoming Ave., Wyoming, Pa.

Circle **636** on inquiry card.

RADIOACTIVITY

Dosimeters. New 4-page Bulletin 3042 presents data on maker's personal and area dosimeters.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle **637** on inquiry card.

Radiation Survey Meters. Four new Bulletins (3038, 3034, 3043 and 3044) describe maker's radiation measuring instruments and accessories, also presents specifications on "CD V-700 and CD V-720" survey meters.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle **638** on inquiry card.

AIR

Air Filter. New 4-page Bulletin 1505-3 describes and illustrates construction, installation, testing and performance of maker's "M-S-A Ultra-Aire" space filter.—Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Penna.

Circle **639** on inquiry card.

MOISTURE

Moisture Testing Equipment. New 12-page Catalog SL-1 illustrates and describes maker's moisture testing equipment for analyzing amount of moisture in solid, granular, liquid or semi-liquid material.—Harry W. Dietert Co., 9330 Roselawn, Detroit 4, Mich.

Circle **640** on inquiry card.

Evaporation Test Cell. New 2-page Bulletin 719 pictures and describes maker's evaporation test cell for determining evaporation losses of grease and oil.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **641** on inquiry card.

LABORATORY

Chromatography, Paper Electrophoresis. New 28-page Catalog AC-56 presents large line of paper electrophoresis apparatus and equipment.—

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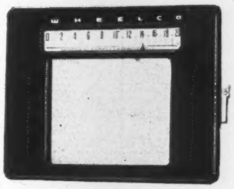

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For more information circle **190** on inquiry card.

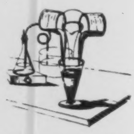
NEW LITERATURE

Schaar and Co., 754 W. Lexington St., Chicago 7, Ill.
Circle **642** on inquiry card.

Homogenizer. New 4-page illustrated Bulletin LH-55 describes maker's lab homogenizer for pilot plant or limited production operations.—Manton-Gaulin Mfg. Co., 44 Garden St., Everett 49, Mass.
Circle **643** on inquiry card.

Lab Apparatus. New 4-page Bulletin 5520 pictures and describes maker's "Blue M" electric ovens and furnaces, "Magni-Whirl" utility water baths, etc.—Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.
Circle **644** on inquiry card.

Sieves, Ovens. Two new 2- and 4-page bulletins describe maker's "Blue M" single-wall gravity ovens, sieves, sieve shakers, sample splitters, etc.—Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.
Circle **645** on inquiry card.



ANALYTICAL

Spectrophotometer, Accessories. New 4-page Brochure FD-104-156 describes maker's "Model 21" double-beam infrared spectrophotometer; 4-page Brochure presents line of accessories.—Perkin-Elmer Corp., Norwalk, Conn.
Circle **646** on inquiry card.

CO_2 Recorders. New 4-page Catalog 56-553-1 presents principles of maker's CO_2 analyzers and recorders based on absorption of CO_2 from a burretted sample.—Hays Corp., Michigan City, Ind.
Circle **647** on inquiry card.

Spectrochemical Analysis. New 4-page folder describes basic principles, equipment and process of quantitative spectrographic chemical analysis via "SpecTrol" apparatus.—National Spectrographic Laboratories, Inc., 6300 Euclid Ave., Cleveland 3, Ohio.
Circle **648** on inquiry card.

Photometer. New 2-page Bulletin TDS-1370 presents maker's UV-IR photometer designed to measure radiation in selected spectral bands corresponding to various specific film types.—Servo Corp. of America, New Hyde Park, N. Y.
Circle **649** on inquiry card.

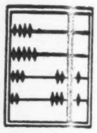
Spectrophotometer. New 4-page Bulletin D-4843 presents "DK-1" ratio recording spectrophotometer featuring spectral range of 185 to 3500 mu.—Harshaw Scientific, 1945 E. 97th St., Cleveland 6, Ohio.
Circle **650** on inquiry card.

Spectrophotometer Accessories. New 2-page Bulletin 479 describes accessories for maker's "DK" recording spectrophotometers.—Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.
Circle **651** on inquiry card.

Spectrochemical Excitation Unit. New 8-page Catalog V2-56 presents all-in-one excitation unit for spectrochemical analysis.—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.
Circle **652** on inquiry card.

pH Paper. New 4-page folder includes a ready reference selector chart for selecting maker's "pHydrion" short range papers.—Rascher & Betzold, Inc., 730 N. Franklin St., Chicago 10, Ill.
Circle **653** on inquiry card.

COMPUTING, DATA HANDLING



Digitizers. New 6-page Bulletin CR-185 describes maker's "Digitizers" that translate shaft position into binary digits. Also new 4-page Bulletin CR-181 describes and presents typical applications for electromechanical decimal "Digitizer" in data automation systems.—Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles 16, Calif.
Circle **654** on inquiry card.

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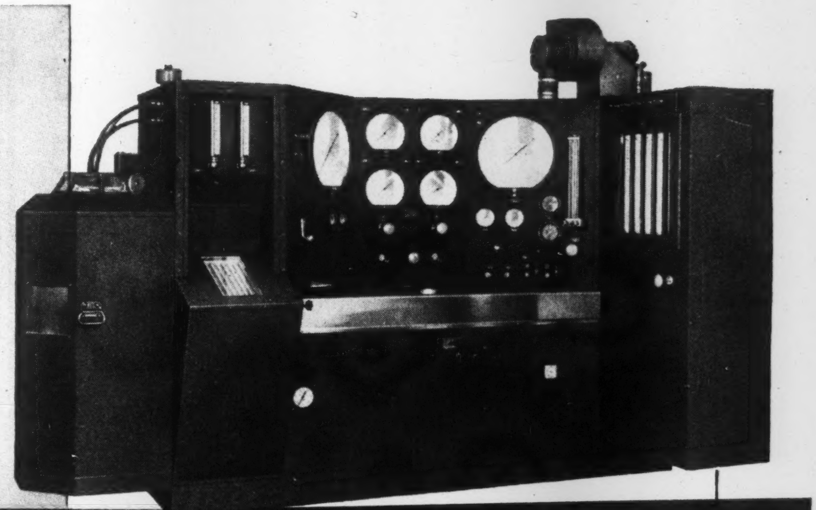

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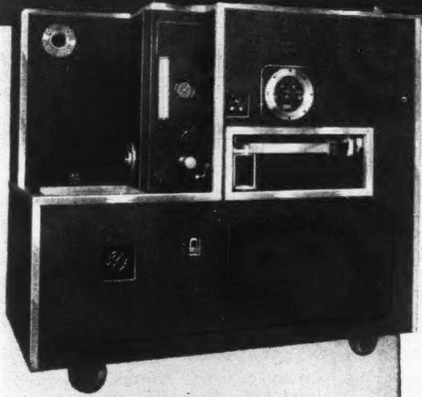
Used by the aircraft industry to test for optimum efficiency of jet fuel nozzles, this highly accurate Cox Test Stand is a "complete modern hydraulics laboratory." Pressure, temperature, and flow rate can be controlled during testing to simulate the actual conditions under which jet fuel nozzles normally operate in the engine.



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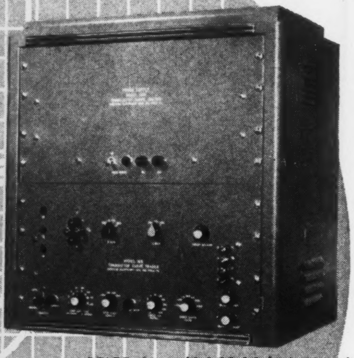

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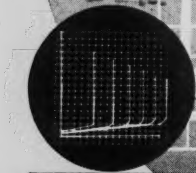

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For more information circle **194** on inquiry card.

NEW LITERATURE

Operational Amplifiers. New 32-page bulletin is "Applications Manual for Philbrick GAP/R K2 octal plug-in Computing Amplifiers."—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Circle **655** on inquiry card.

Simulation, Data Reduction. New 18-page bulletin describes available "One Source" analog computing service for simulation, computing, data reduction and data processing.—J. B. Rea Co., Inc., Santa Monica, Calif.

Circle **656** on inquiry card.

Magnetic Tape Handler. New 2-page data sheet describes maker's "Model 101" digital magnetic-tape handler featuring 5-ms start-stop time.—Key Electric Corp., 287 Post Ave., Westbury, N. Y.

Circle **657** on inquiry card.

Digital Computing. New 12-page brochure pictures and describes maker's new "Litton 20" miniature DDA computer for solving differential equations.—Litton Industries, 336 N. Foothill Rd., Beverly Hills, Calif.

Circle **658** on inquiry card.

C-R Storage Tubes. Two new 4-page Bulletins P5-LP-JM-56 and P6-GP-JM-56 describes maker's "Memotron and Tonotron" direct-display storage tubes.—Hughes Products Div. of Hughes Aircraft Co., Los Angeles 45, Calif.

Circle **659** on inquiry card.

Data Processing. New 120-page Bulletin MI-118 discusses "continuous and integrated operation of data processing using automatic machines" and the various types of commercially available machines.—Mr. Bower, Moore Business Forms, Inc., Niagara Falls, N. Y.

Circle **660** on inquiry card.

Dials, Code Discs. New 4-page bulletin describes and illustrates maker's dials, divided circles, complex wave forms, digital coding discs and sine-wave frequency standards.—Precision Photomechanical Corp., 170 S. Van Brunt St., Englewood, N. J.

Circle **661** on inquiry card.

Univac. New 6-page illustrated Brochure TM-953 describes application of "Univac 120" punched-card computer by Rexall Drug Co.—Remington Rand Univac Div., Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.

Circle **662** on inquiry card.

Analog-Digital Converter. New 2-page Data Sheet 2-A introduces new "LiAD" low-current digital converter based on D'Arsonval movement with pointer pressed against coded plate for conversion.—Assembly Products, Inc., Wilson Mills Rd., Chesterland, Ohio.

Circle **663** on inquiry card.

RECORDING

Electrophotographic Oscillograph. New 2-page Bulletin CGC-311 presents new-principle direct-writing "Model 420" electrophotographic recording oscillograph featuring light-beam recording on Electrofax charged paper, and development within seconds.—Century Electronics & Instruments, Inc., 1333 No. Utica, Tulsa, Okla.

Circle **664** on inquiry card.

Oscillographic Recorder. New 8-page brochure presents new "Acton 550 A" 8-channel direct-writing oscillographic recorder featuring 1000-cps response and scribing on carbon-coated film.—Acton Laboratories, Inc., 533 Main St., Acton, Mass.

Circle **665** on inquiry card.

Oscillograph Recorder, Phase Meters. New 8-page bulletin describes and illustrates maker's oscillographic recorder, phase meters, amplifiers, VTVM, complex plane analyzer, oscillator, etc.—Acton Laboratories, Inc., 533 Main St., Acton, Mass.

Circle **666** on inquiry card.

Curve Plotter. Two new 2-page bulletins present principles and operation of maker's automatic curve plotter and describes facsimile equipment used for weather forecasting.—Alden Electronic and Impulse Recording Equipment Co., Westboro, Mass.

Circle **667** on inquiry card.

High-speed Camera. New 8-page bulletin presents technical data and operating characteristics for maker's 16-mm motion-picture camera designed for operation at 200 fps.—Traid Corp., Sherman Oaks, Calif.

Circle **668** on inquiry card.

Missile Cameras, Lenses. Two new 8-page brochures present maker's "100" 16mm camera for missile applications, and telephoto lens.—Traid Corp., Sherman Oaks, Calif.

Circle **669** on inquiry card.

Strip Chart Markers. New 4-page bulletin presents maker's "Identi-charts" that print identifying marks on strip charts from a remote control point to show the exact time or in what sequence conditions occur.—Royson Engineering Co., Hatboro, Pa.

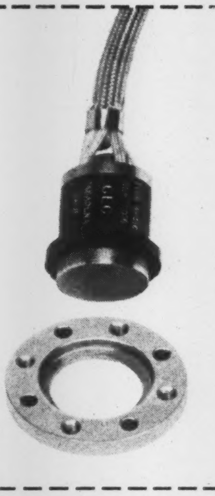
Circle **670** on inquiry card.

Copy Machine. New 4-page bulletin describes maker's "Exact-Phote" portable photocopy machine.—General Photo Products Co., Inc., General Photo Bldg., 15 Summit Ave., Chatham, N. J.

Circle **671** on inquiry card.

RATE GYROS

Rate Gyroscopes. New 4-page Brochure SA78-3 describes maker's rate gyroscopes used in guided missiles,



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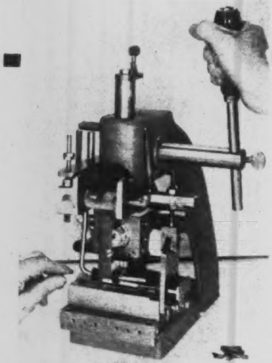

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autopilots, etc.—The United States Time Corp., 500 Fifth Ave., New York 36, N. Y.

Circle **672** on inquiry card.

MOTION, VIBRATION

Tachometers. New 4-page Bulletin AT 135 describes maker's hand tachometers for measuring rotational, lineal and surface speeds.—Clarence J. Marx Co., P. O. Box 4033, Cleveland 23, Ohio.

Circle **673** on inquiry card.

Balancing Machine. New 4-page bulletin illustrates maker's dynamic balancing machine designed for production testing of rotating parts.—R. B. Annis Co., 1101 N. Delaware St., Indianapolis 2, Ind.

Circle **674** on inquiry card.

ULTRASONICS

Ultrasonic Systems. New 4-page Bulletin MW-103 describes benefits derived from ultrasonic techniques in cleaning and degreasing, electroplating, drilling and grinding operations.—Acoustica Associates, Inc., Glenwood Landing, L. I., N. Y.

Circle **675** on inquiry card.

MAGNETICS

Permanent Magnets. New 12-page Manual 5-R is a reference booklet on materials and principles for selection of permanent magnets. Includes glossary of terms.—The Indiana Steel Products Co., Valparaiso, Ind.

Circle **676** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Oscilloscopes. New 4-page bulletin presents maker's "130A" low-frequency oscilloscope and "150A" high-frequency oscilloscope.—Hewlett-Packard Co., 3636 Page Mill Rd., Palo Alto, Calif.

Circle **677** on inquiry card.

Low-Level DC Amplifier. New 4-page Data Sheet 80-1 presents principles and applications of d-c amplifier based on torque-opposed D'Arsonval movement.—Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.

Circle **678** on inquiry card.

Syncroverter Switch. New 4-page Bulletin AV2002 presents principles and specs of miniature "Syncroverter" switch, a low-power precision inverter (dc-to-ac) for use over excitation frequency range of 0-1800 cps.—The Bristol Co., Waterbury 20, Conn.

Circle **679** on inquiry card.

Frequency Indicators. New 2-page Data Sheet F.1 presents expanded-scale 400-cycle frequency meters for panel mounting.—Arga Div., Beckman Instruments, Inc., 220 Pasadena Ave., S. Pasadena, Calif.

Circle **680** on inquiry card.

Transistor Amplifier. New 2-page specification sheet presents data on maker's "VS-63A and VS-64A" hushed transistor pre-amplifiers for d-c and a-c operations.—Volkers & Schaffer Mfg. Corp., Box 996, Schenectady, N. Y.

Circle **681** on inquiry card.

Induction DC-AC Modulator. New 4-page reprint describes "Model 1403" induction modulator for converting DC to AC.—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Circle **682** on inquiry card.

VTVM. New 4-page Bulletin 7409 presents new "Microlter" line of wide-band, high-frequency, low-level vacuum-tube voltmeters; also described are sweeping oscillators, signal generator, low-power color TV picture and sound transmitters and noise generators.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle **683** on inquiry card.

Signal Generator. New 4-page bulletin (Form 295X 955H) presents new universal, all-band microvolt and crystal-controlled generator that provides a microvolt source from 125 kc to 175 Mc, and an r-f source for frequency adjustment to crystal accuracy.—The Hickok Electrical Mfg. Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle **684** on inquiry card.

Insulation Testers. New 4-page Bulletin 1248 presents maker's line of insulation and resistance testers, including hand cranking dc generator type, battery vibrator type, plug-in type and electronic type that measures resistances up to 20 million megohms.—Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.

Circle **685** on inquiry card.

Transconductance Analyzer. New 4-page brochure presents maker's transconductance analyzer and circuit designer that reads dynamic transconductance under controlled static conditions.—New London Instrument Co., Inc., New London, Conn.

Circle **686** on inquiry card.

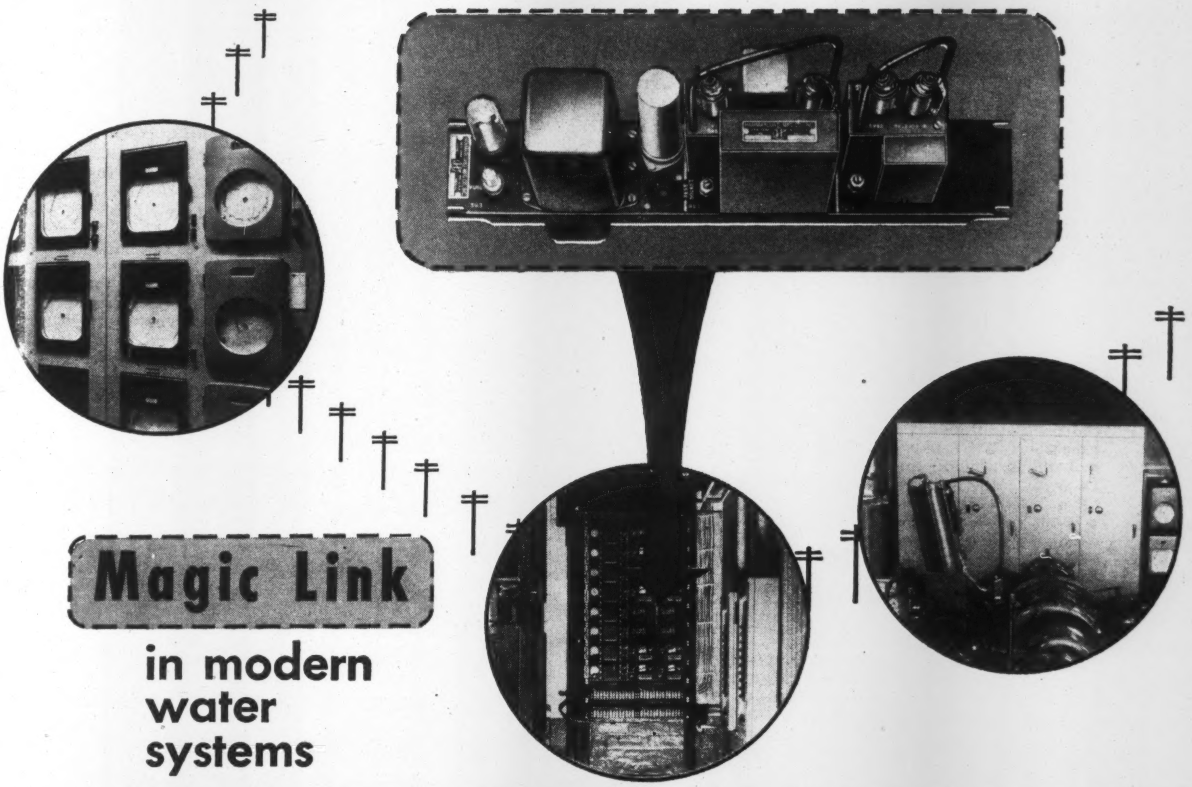
Frequency Limit Indicators. New 2-page Data Sheet D 1 presents operation of maker's frequency limit indicators that include two circuits—one that operates when frequency is higher than critical and one that operates when frequency is lower than critical.—Arga Div., Beckman Instruments, Inc., South Pasadena, Calif.

Circle **687** on inquiry card.

Digital VTVM. New 2-page bulletin presents "Model 615" digital VTVM featuring overload protection and 1% accuracy.—Hycon Electronics, Inc., 321 So. Arroyo Parkway, Pasadena, Calif.

Circle **688** on inquiry card.

Panel Instruments, Meter Relays. Twelve new 2-, 4-, and 6-page Bulletins (A-97, A-88, A-98, 2056, 3001, A-103, A-2600, ADV. 3SPC and 2052)



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Hammarlund COC equipment permits supervision and control of an entire water system from a single, central control location.
It relieves present personnel to perform more important work in maintaining high quality service to your customers. COC can start or stop pumps, open or close valves proportionally, remotely record flow, pressure and level at all stations.

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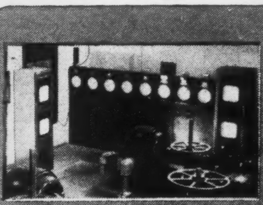
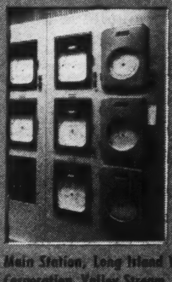
Get the complete story on COC equipment. See how it can pay for itself in short order, and how it can improve and modernize your water system.

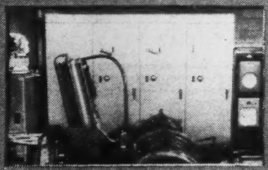
Send for descriptive brochure Bulletin I-556.



Main station of Jamaica Water Supply Company, Jamaica, N. Y. Using standard telephone lines, pumps and valves are controlled and telemetering information is received from five remote stations.



Main Station, Long Island Water Corporation, Valley Stream, N. Y. Hammarlund COC equipment provides means for telemetering entire system.



Remote Station #13 of Long Island Water Corporation, East Oceanside, N. Y. Personnel at Main Station can control butterfly valve to regulate filling of storage tanks and can start and stop remote station pumps.

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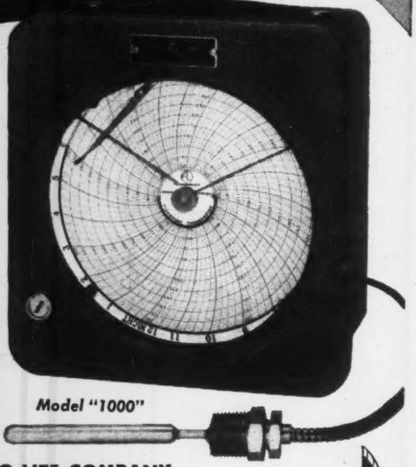

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describe maker's Model 269 Microammeter, Model 355 Midgetester, Models 262 and 2600 volt-ohm-milliammeters, Model 397 line quality tester, Model 434 "White Dot" generator, Model 498 portable field strength meter, meter relays, panel instruments, and Model 388 Therm-O-Meter.—Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

Circle **689** on inquiry card.

VTVM Microvoltmeter/microammeter. New 2-page bulletin presents maker's d-c microvolt ammeter and amplifier "Model 203" featuring chopper amplifier and lowest range of 100 mv with input impedance of 10 megohms.—Kay Lab, 5725 Kearney Villa Rd., San Diego 12, Calif.

Circle **690** on inquiry card.

Potentiometric Voltmeter. New 2-page bulletin presents "Model 801" precision potentiometric d-c voltmeter with 5-place readant.—John Fluke Mfg. Co., Inc., 7777 W. Nickerson St., Seattle 99, Wash.

Circle **691** on inquiry card.

Atomichron Frequency Standard. New 8-page bulletin presents maker's "Atomichron" primary frequency standard based on resonance frequency of cesium atoms, "NC-300" 10-band communications receiver, components, etc.—National, 61 Sherman St., Malden 48, Mass.

Circle **692** on inquiry card.

Miniature VTVMs. New 4-page Catalog VM-106 describes maker's line of miniature, panel-mounting vacuum-tube voltmeters.—Trio Laboratories, Inc., 4025 Merrick Rd., Seaford, L. I., N. Y.

Circle **693** on inquiry card.

Telemetering Receivers. New 2-page bulletin presents electrical and mechanical specifications of maker's FM/FM telemetering receivers.—Nems-Clarke, Inc., 919 Jesup-Blair Silver Spring, Md.

Circle **694** on inquiry card.

Mixer-Amplifier. New 2-page Bulletin TP101 describes maker's mixer-amplifier used in remote broadcasting and recording.—Baird Associates, Inc., 33 University Rd., Cambridge 38, Mass.

Circle **695** on inquiry card.

IF Amplifier. New 4-page bulletin describes and illustrates maker's IF amplifiers for radar and guided missiles.—Lel Inc., 380 Oak St., Copiague, L. I., N. Y.

Circle **696** on inquiry card.

UHF Attenuators. New 8-page brochure describes maker's line of coaxial attenuators and coaxial line terminations.—Stoddart Aircraft Radio, Inc., Hollywood 38, Calif.

Circle **697** on inquiry card.

POWER SUPPLIES

Transistorized Power Supplies. Two new 2-page Catalog Sheets 1-30-56

and 2-15-56, and 5-page technical bulletin, describe maker's new line of transistorized regulated power supplies for up to 300 v at 200 ma.—Electronic Research Associates, Inc., 67 E. Centre St., Nutley 10, N. J.
Circle **698** on inquiry card.

DC Power Supplies. New 4-page Supplement to Catalog 55 presents a check list of models, prices and specs of maker's regulated and unregulated dc power supplies.—Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y.
Circle **699** on inquiry card.

Voltage Regulators. New 2-page Data Sheet Y.1 presents specifications on maker's a-c voltage regulators for engine-driven alternators.—Arga Div., Beckman Instruments, Inc., So. Pasadena, Calif.
Circle **700** on inquiry card.

Power Rectifiers. New 8-page illustrated Bulletin AC-56-A presents data on maker's "Stavolt" power rectifiers for d-c voltage applications.—McColpin-Christie Corp., 3410 W. 67th St., Los Angeles 43, Calif.
Circle **701** on inquiry card.

RESISTORS, POTENTIOMETERS

Subminiature Potentiometers. New brochure contains 9 2-page bulletins that presents maker's wirewound, carbon, solder-lug, high-temperature, variable resistor and humidity-proof subminiature potentiometers.—Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.
Circle **702** on inquiry card.

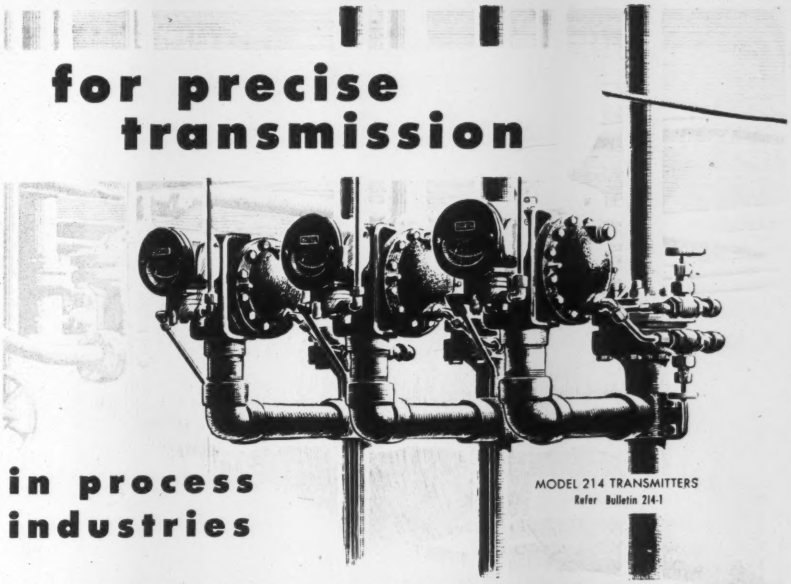
Trimming Potentiometer. New 2-page Bulletin 130/6/A describes maker's "Trimpot" subminiature trimming potentiometer.—Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.
Circle **703** on inquiry card.

Resistors. New 4-page Bulletin PH describes maker's "Series PH" encapsulated precision wire-wound resistors.—Hycor Div. of International Resistance Co., 12970 Bradley Ave., Sylmar, Calif.
Circle **704** on inquiry card.

Vernistat. New 4-page bulletin describes maker's 400-cycle "Vernistat" a-c potentiometer that translates shaft rotation to a-c voltage output.—Vernistat Div., Perkin-Elmer Corp., Norwalk, Conn.
Circle **705** on inquiry card.

Resistor Chart. New file-size chart presents electrical and mechanical characteristics of maker's variable composition resistors.—Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.
Circle **706** on inquiry card.

Potentiometers. New 6-page leaflet presents specifications on maker's "Helipot" precision multiturn potentiometers.—Servonics, Inc., 834 N. Henry St., Alexandria, Va.
Circle **707** on inquiry card.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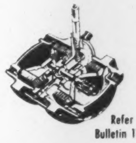
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MODEL 199 METER BODY

Refer Bulletin 11C4
MODEL 200 INDICATOR

Refer Bulletin 11C4
MODEL 202 RECORDER

Refer Bulletin 211-1
MODEL 211 FLOW SWITCH

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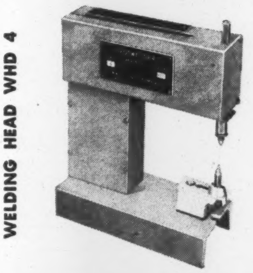
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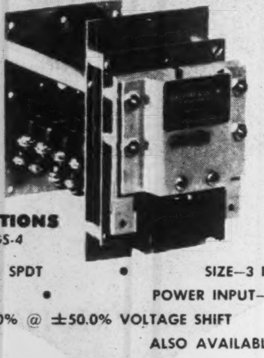

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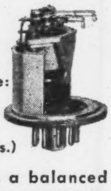

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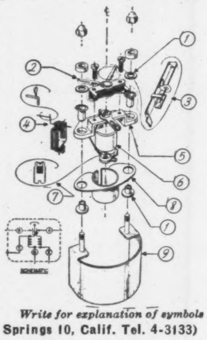

Write for explanation of symbols

For more information circle 205 on inquiry card.

RELAYS SWITCHES,

Relay Testing. New 4-page Data Sheet 156UB discusses protective relay maintenance and testing with particular attention to equipment and records necessary for assuring safe operation of relays and breakers in protective uses.—Multi-Amp Corp., 10 Third St., Newark, N. J.

Circle **708** on inquiry card.

Switches. New 2-page Data Sheets P108 and 109 and 4-page issue of "Uses Unlimited" (Vol. 10, No. 1) present maker's subminiature door interlock switch, "Electrical Memory" toggle switch, and typical applications of switches.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **709** on inquiry card.

Switches. New 4-page issue of "Micro tips" (Vol. 1, No. 19) features article "Switches Aid Automatic Movement of Automatic Washers."—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **710** on inquiry card.

Oil-Well Pumping Starters. New 4-page Bulletin GEA-6410A presents information and features of oil-well pumping starter, including new combination timer, ventilated overload relay compartment and gasketed enclosure.—General Electric Co., Schenectady 5, N. Y.

Circle **711** on inquiry card.

TRANSISTORS, TUBES

VHF Transistors. New 2-page Bulletin DL-S 619 presents ratings and characteristics of Type 501 PNP new grown-diffused germanium tetrode transistor designed especially for vhf operation to 200 Mc. Also new 2-page Bulletin DL-S 620 presents Type 925 PNP new grown-diffused silicon tetrode transistor designed especially for amplifier applications at frequencies up to 12.5 Mc. Also new 2-page Bulletin DL-S 621 presents new Type 926 PNP grown-diffused silicon tetrode transistor designed for amplifer application to 30 Mc.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas.

Circle **712** on inquiry card.

Transistor Price List. New Price Lists (PL-S 609 and PL-S 610) list prices on 54 silicon devices and germanium transistors, including general-purpose, switching, high frequency, power types, etc.—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Tex.

Circle **713** on inquiry card.

Bi-Directional Transistors. New 2-page Tent. Spec. Bulletin GT-34S presents new PNP bi-directional transistor for clamps and other circuits requiring bi-directional gain. New Bulletins GT-88 and GT-760 describes maker's germanium PNP alloyed

junction transistors.—General Transistor Corp., 95-18 Sutphin Blvd., Jamaica 35, N. Y.
Circle **714** on inquiry card.

Tandem Transistors. New 4-page bulletin on tandem transistors presents fundamental circuitry, applications, etc. of new tandem transistor (two dc-coupled units in single case). —Marvelco Electronics Div., National Aircraft Corp., 3411 Tulare Ave., Burbank, Calif.
Circle **715** on inquiry card.

Cathode-Ray Tubes. New data sheet lists characteristics of 74 "Custom-Line" cathode-ray tubes.—Industrial Tube Dept., Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J.
Circle **716** on inquiry card.

PNP Junction Transistor. New 2-page bulletin ECG-87 describes maker's type 2N107 diffused junction transistor that will dissipate 50 milliwatts in free air, and recommended for students and experimenters.—General Electric, Electronics Park, Syracuse, N. Y.
Circle **717** on inquiry card.

Electron Tubes. New 16-page Brochure PA-1 presents list of maker's miniature electron tubes.—CBS-Hytron Div. of Columbia Broadcasting System, Inc., Danvers, Mass.
Circle **718** on inquiry card.

Microwave Tubes and Components. New 6-page leaflet presents specifications on maker's TR, ATR, Pre-TR and attenuator tubes, spark gap tubes, silicon diodes, etc.—Bomac Laboratories, Inc., Beverly, Mass.
Circle **719** on inquiry card.

Electron Tubes. New 4-page data sheet presents information on maker's tubes—rectifiers, power triodes, VR tubes, thyratrons, clipper diodes, etc. —Chatham Electronics, Div. of Gera Corp., Livingston, N. J.
Circle **720** on inquiry card.

Klystron Tube Index. New 4-page bulletin is an index and application chart of maker's "Klystron" tubes for L, S, C, X and K bands.—Varian Associates, 611 Hansen Way, Palo Alto, Calif.
Circle **721** on inquiry card.

Tube Socket. New 2-page Technical Data Sheet 50A presents breakdown voltages and all specifications of "Series 1550 Type B" duodecal tube socket.—DeJur-Amsco Corp., 54-01 Northern Blvd., Long Island City 1, N. Y.
Circle **722** on inquiry card.

ELECTRONIC COMPONENTS

Cable, Wire. New 40-page Catalog 55 describes maker's shielded, audio and multi-conductor cables, hook-up, subminiature and high-voltage wires, power cords, etc.—Alpha Wire Corp., 430 Broadway, New York 13, N. Y.
Circle **723** on inquiry card.

Connectors. New 2-page Catalog insert 48E presents new 51-contact

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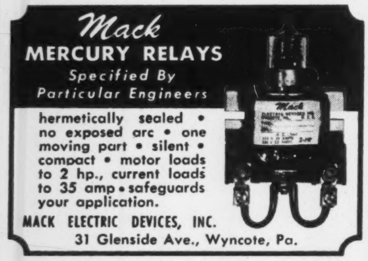

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NEW LITERATURE

connector with hermetic seal.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **724** on inquiry card.

Connectors. New 8-page issue of "Amphenol Engineering News" (Vol. 9, No. 2) describes use of maker's connectors in portable tachometer tester, pulse data systems, etc.—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle **725** on inquiry card.

Ceramic Capacitors. Four new 2-page Bulletins (TC-1A, HC1A, MP-1A and MIN-1A) present information on maker's ceramic capacitors, including design features, temperature characteristic curves, specifications — Glenco Corp., Metuchen, N. J.

Circle **726** on inquiry card.

Rectifiers, Transformers. New 4- and 8-page bulletins describe and illustrate maker's "unitized" rectifiers, filter reactors, rectifier plate transformers, etc.—Magnetran Inc., Kearny, N. J.

Circle **727** on inquiry card.

Electrolytic Capacitors. New 4-page bulletin CS33 presents catalog and performance data on maker's line of hermetically-sealed, miniature, aluminum-foil electrolytic capacitors — Barco, Inc., Milwaukee 1, Wis.

Circle **729** on inquiry card.

Wound Cores. New 32-page Bulletin WC-356 covers maker's line of "OrthoSil" wound cores.—Thomas & Skinner, Inc., 1120 E. 23rd St., Indianapolis 7, Ind.

Circle **730** on inquiry card.

MECHANICAL COMPONENTS

Cap Screws. New 4-page Bulletin DM-737 presents maker's socket cap

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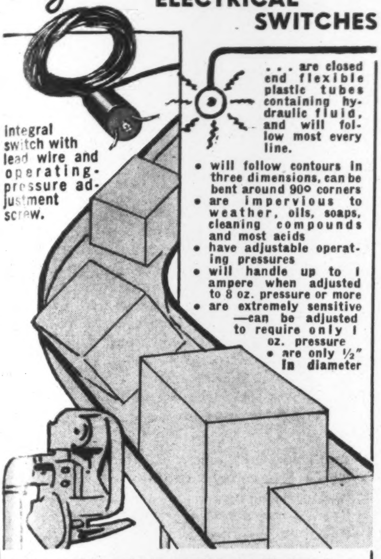
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screws featuring high holding power.—Bristol Co., Waterbury 20, Conn.

Circle **731** on inquiry card.

Screw Feeder. New 2-page Bulletin 738 presents specifications of maker's automatic socket set screw feeder and driver.—Bristol Co., Bristol Rd., Waterbury 20, Conn.

Circle **732** on inquiry card.

Gear Train Design. New 8-page illustrated booklet describes production techniques used in gear train design and production.—Washington Machine and Tool Works, Inc., 1001 Washington Ave. So., Minneapolis 15, Minn.

Circle **733** on inquiry card.

Precision Gears, Bearings. New 68-page Catalog 7 and 28-page Catalog 8 cover maker's line of gears, bearings, differentials, couplings, reducers, etc., available from stock.—PIC Design Corp., 160 Atlantic Ave., Lynbrook, N. Y.

Circle **734** on inquiry card.

Glass Pipe, Fittings. New 4-page Catalog 80-10 describes and illustrates maker's glass pipe and fittings fabricated from Pyrex tubing.—Fischer & Porter Co., 683 Jacksonville Rd., Hatboro, Pa.

Circle **735** on inquiry card.

Precision Bearings. New 32-page illustrated Catalog AFB-1 presents specs and data on maker's large line of precision bearings.—Industrial Tectonics, Inc., 3684 Jackson Rd., Ann Arbor, Mich.

Circle **736** on inquiry card.

"O" Ring Seal. New Engineering Handbook 525 presents data in development of "O" ring seal design on external and internal grooves, gland finishes, chamfers, piston rod, etc.—Plastic and Rubber Products Co., 2100 Hyde Park Blvd., Los Angeles 47, Calif.

Circle **737** on inquiry card.

Threaded Inserts. New 2-page data sheet presents specs on maker's line of threaded and knurled inserts for plastics, rubber, die castings and potting compounds.—Standard Insert Co., 12270 Montague St., Pacoima, Calif.

Circle **738** on inquiry card.

Indexing Units. New 24-page Catalog 106 contains full selection and application data on maker's high-speed indexing (positioning) mechanisms based on cam rib with ball-bearing followers.—Ferguson Machine & Tool Co., P.O. Box 5841, St. Louis 21, Mo.

Circle **739** on inquiry card.

SERVOMECHANISM KITS

Servomechanism Kit. New 16-page Bulletin TDS 1110 describes and illustrates maker's "Servoboard" servomechanism kit.—Servo Corp. of America, New Hyde Park, N. Y.

Circle **740** on inquiry card.

Mechakits. New 4-page Bulletin C51-055M presents specifications on maker's "K102, K103 and K104"

Continued on page 1040

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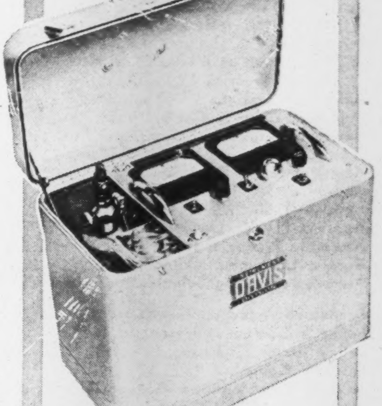

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NEW LITERATURE

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servomechanism kits.—Servomechanisms, Inc., 625 Main St., Westbury L. I., N. Y.
Circle **741** on inquiry card.

MAGNETIC CLUTCHES

Gears, Magnetic Clutches. New 4-page brochure presents maker's precision components—gear heads, differentials, etc.—Sterling Precision Corp., 34-17 Lawrence St., Flushing 54, N. Y.
Circle **742** on inquiry card.

Hysteresis, Magnetic Clutches. New 32-page brochure presents specifications on hysteresis and magnetic clutches and brakes, pillow blocks, brush assemblies, etc.—Electro Mechanical Div., General Riveters, Inc., 785 Hertel Ave., Buffalo 7, N. Y.
Circle **743** on inquiry card.

Magnetic Clutches, Magnetic Amplifiers, Transformers. New 4-page Bulletin G-3 gives basic specs on line of magnetic clutches, magnetic amplifiers, toroid coils, etc.—Hycor Div. of Int'l. Resistance Co., 12970 Bradley Ave., Sylmar, Calif.
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FABRICATION

Chemical Wire Strippers. New 4-page bulletin describes maker's chemical wire strippers for stripping insulation from armature and coil leads.—London Chemical Co., Inc., 1535 N. 31st Ave., Melrose Park, Ill.
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Formulation Process. Grinding Formulation. New 12-page booklet presents information on electronic formulation process for grinding wheel manufacture.—Bay State Abrasive Products Co., Westboro, Mass.
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Custom Electronic Equipment. New 12-page brochure presents facilities and staff for manufacture of custom electronic precision equipment.—The Newton Co., Manchester, Conn.
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Automatic Lubricators. New 2-page Bulletin 3B describes maker's line of high-pressure, automatic lubricators driven through reduction gears by the machines on which they are used.—Bijur Lubricating Corp., 151 W. Passaic Street, Rochelle Park, N. J.
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MATERIALS

Precision Strip. New 8-page Bulletin 7 presents data on maker's thin-gage beryllium copper, phosphor bronze, nickel silver, chromium copper, etc.—Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.
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Packaging Material. New 16-page booklet presents principles of packaging, and data on rubberized Texlite hair used in packaging of electronic instruments.—B. F. Goodrich., Sponge Products Div., Shelton, Conn.
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Alumina Ceramics. New 4-page Bulletin 562 presents data on maker's A1SiMag alumina ceramics.—American Lava Corp., Chattanooga 5, Tenn.
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Potting Compound. New 2-page bulletin describes properties of maker's new potting compound.—Bacon Industries, Inc., Watertown, Mass.
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Luminescent Products. New 6-page folder describes and illustrates maker's luminescent products including paints, inks, ultraviolet lighting, etc.—Gardner Laboratory Inc., Bethesda 14, Md.
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Cemented Oxide. New 4-page "Technical Report #2" presents information for applying cemented-oxide tool materials.—Carboloy Dept., General Electric, Detroit 32, Mich.
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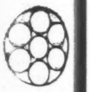
TUBING



Tubing Tools. New 2-page Bulletin 3057 presents maker's new combination tube cutter and tube constructor, also includes test plugs for temporarily shutting off tubing.—The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.
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Tubing Support. New 12-page Bulletin 255 describes maker's support system for instrument tubing.—Instrof, Inc., 711 S. 50th St., Philadelphia 43, Pa.
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Cable Ladder. New 12-page Bulletin 156-E presents specifications on maker's ladder-type rack and hangers for supporting power and control cables and instrument air piping.—P-W Industries, Inc., Duncan and Melrose Sts., Phila. 24, Pa.
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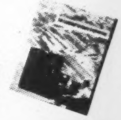

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